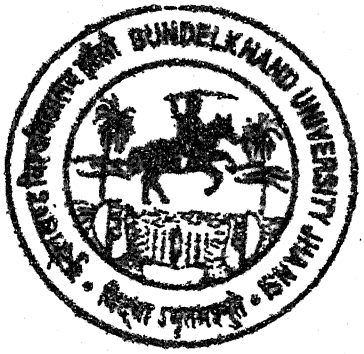
"Effect of sowing dates, planting geometry and varieties on growth, yield and quality of mustard (*Brassica juncea coss.*) under irrigated condition."



THESIS

SUBMITTED TO

BUNDELKHAND UNIVERSITY, JHANSI

FOR THE DEGREE

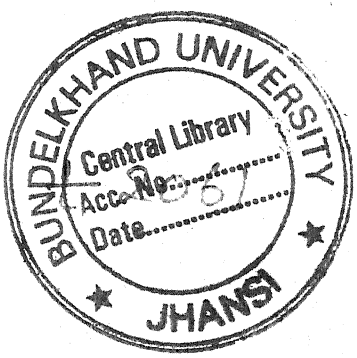
OF

DOCTOR OF PHILOSOPHY

IN

AGRONOMY

2006



BY

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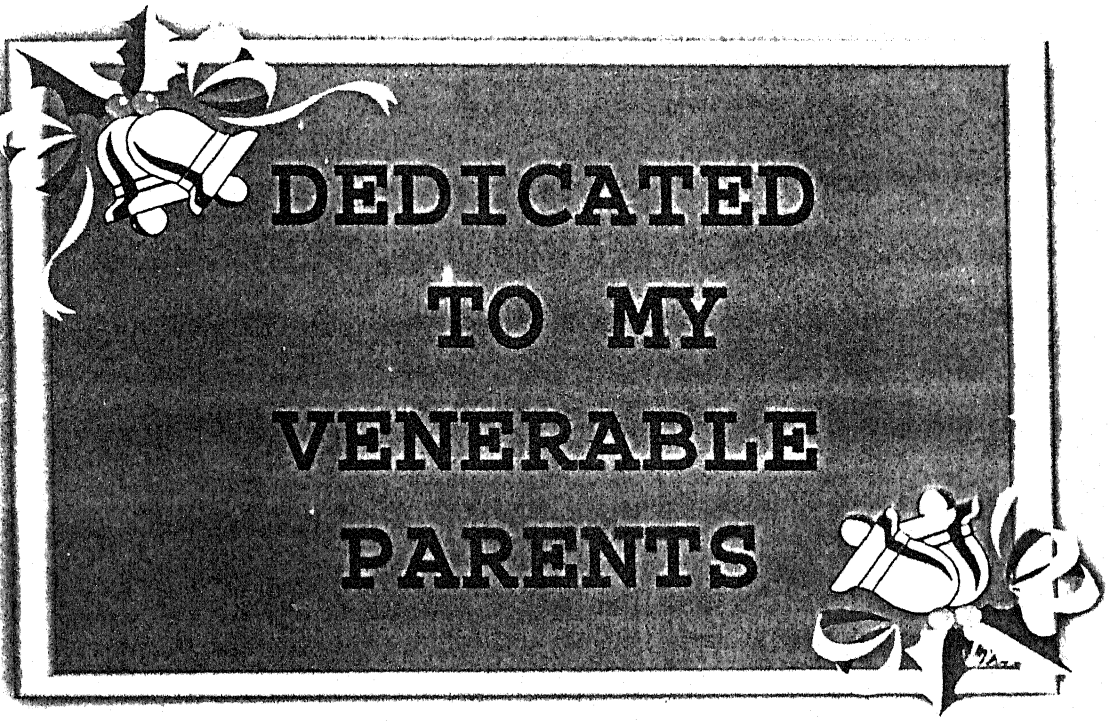
INDIA


DEDICATED
TO MY
VENERABLE
PARENTS

Dr. U.P. Singh
M.Sc.(Ag.), Ph.D.

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Rath (Hamirpur) U.P.

CERTIFICATE

This is to certify that Thesis work entitled "**Effect of Sowing dates, Planting Geometry and Varieties on Growth, Yield and quality of Mustard (*Brassica juncea coss*) under irrigated condition**" is an original piece of research work done by **Mr. Ram Kumar Singh Mahan** under my supervision for the degree of Doctor of Philosophy in Agronomy of Bundelkhand University, Jhansi (U.P.).

I further certify that :-

(a) The Thesis has been completed.

(b) The embodies the work of candidate himself.

(c) It is an original piece of research work.

(d) The Thesis fulfill the requirement attendance as laid down by the University.

(e) It is up to standard in respect of its contents and literacy presentation for being referred to examiners.

Dated :02-05-2006

(Dr. U.P. Singh)
Dr. U.P. Singh
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Rath (Hamirpur) U.P.

CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

DECLARATION

I hereby declare that the thesis entitled "Effect of Sowing dates, Planting Geometry and Varieties on Growth, Yield and quality of Mustard (Brassica juncea coss) under irrigated condition" being submitted for the degree of Doctor of Philosophy in Agronomy of the Bundelkhand University, Jhansi (U.P.) is an original piece of research work done by me and to the best of my knowledge and belief, is not substantially the same one which had already been submitted for the degree or any other academic qualification at any other University or examining body in India or any other country.

(RAMKUMAR SINGH MAHAN)

Rath

Dated : 27.04.2006

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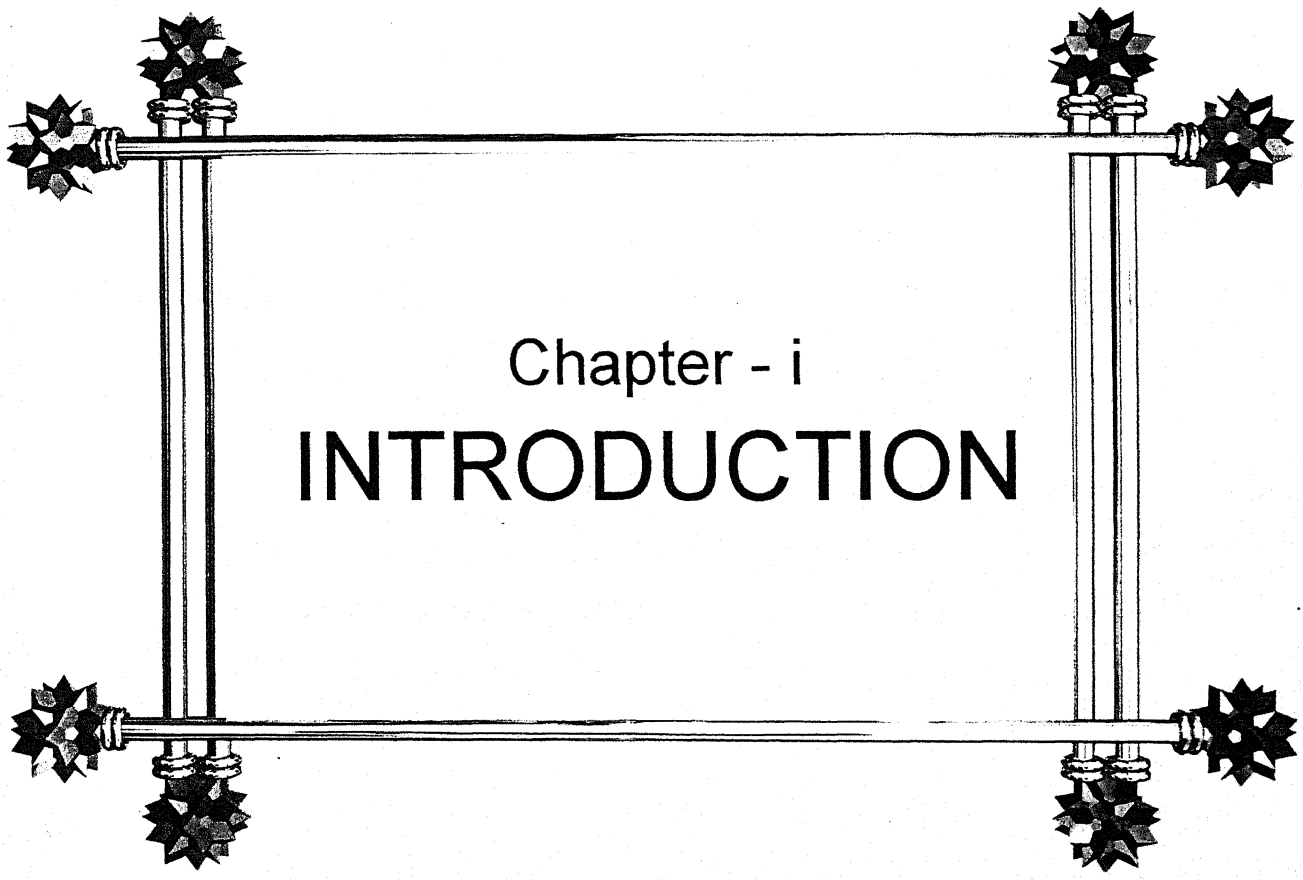
(RAMKUMAR SINGH MAHAN)



Chapter - i

INTRODUCTION

CHPTER - I

INTRODUCTION

Oil seed crops have been the back bone of agricultural economy to India since the time immemorial. The role being played by oil seeds and oil in our national economy needs no renewed emphasis. It is utilized human consumption through out India as oils and medicines. It is also used for lubrication and other agricultural allieds. The importance of oil seeds are also being greatly becoming in India as it constitutes the major dietary part of vegetarian people to supplimentary requirement of fat.

In oil seed crops, the rape seed and mustard seed is the most important for edible oil. The oil obtained is the main cooking media in Northern and Southern India and it can not be replaced by any other edible oil to supplement, constitute to fat for vegetarian people. The mustard is utilized in India as oil, medicines, lubricants, preparation of pickles, curries, vegetables, softening leather and soap making etc. After extraction of oil, cakes is used as cattle feed and manures. The green leaves of young plants are used as vegetable for human which supply enough sulphur and minerals in our diet.

In terms of area and production, India ranks third largest vegetable oil economy in the world after U.S.A. and China. It occupies a premier position in global oil seed scenario accounting for 19% oil seeds area and 9% oil seeds production.

Though the oil seeds production increased from a mere 10.83 million tones to 27.45 million tones in the country was achieved during 2003-2004 (Hegde, 2005). The average productivity of oil seeds in India is only 933Kg/ha as compared to world productivity of 1632 Kg/ha.

Among the nine oil seeds, rape seed and mustard group occupies the prominent position and stand next to ground nut and sharing 14% gross cropped area, 6% of gross national product and 10% of the agriculture product value in India (2003-2004). In India rape seed and mustard is cultivated on a about 5.06 million hectares and the production of 5.83 million tones with the productivity of 1152 Kg/ha (2003-2004). In Uttar Pradesh, rape seed and mustard is grown an area of 6.76 lakh hectares with the production 6.89 lakh tones having the productivity of 1020 Kg/ha (2003-2004).

The production of edible oils is a standing challenge to the country during last two decates, where as the population is also a problem challenge for increasing oil seeds production. The population has reduces the per capita availability of edible oil to about 8.04 Kg against the world average of 15.0 Kg while the per capita consumption of the developed countries is 26.0 Kg. The availability of oil and fat in our country is about 12 g ./day/head against a minimum requirement of 18.0 g./day/head. recommended by F.A.O. The country demand for edible oils is expected to rise more than double form the current level in the next 12 years. In the base scenario of per capita growing by 4%

annually, an average India's yearly edible oil requirement is stated to rise from 9.81 Kg in 1999-2000 to 16.0 Kg by 2015. The per capita edible oil demand will go up to 20.60 Kg is twice the current level by 2014-15 if per capita income grows by 6% (Hegde, 2004).

In India, the gap in demand and supply of edible oil is continuous widering and causing a heavy drain on the foreign exchange reserves of the country, because the country has to import vegetable oils to the tune of more than Rs. 220 million. Therefore, oil seeds production has assumed great importance in India.

According to a recent assessment, the monopoly of mustard oil in the kitchen of the most country homes is gradually yielding place to the other nutrition cooking oil like refined, sunflower oil, rice bran oil, soybean oil and ground nut oil. In this situation, the production and productivity of rape seed and mustard both will be increases to fulfillment the domestic requirement. For fulfillment the demand of fat and oil in our country and state, it is essential to increases mustard production. Among the various factors, suitable sowing time, optimum plant population in relation to fertilization and efficient utilization of plant nutrients with suitable variety are most important. It is widely felt that most of the newly evolved mustard varieties have high yield potential but their tremendous potential is not being realized due to poor agronomic practices and their venerability to insect pests and deceases.

Mustard plant have more plasticity ranges per plant yield from 9.11 g. depending upon area occupied and branching behaviour. Thus it is essential to find out the suitable sowing time and optimum plant population/unit area. For optimizing the economic yield of any crop/variety, the optimum sowing time and plant population is a prerequisite. The time of sowing crop depend upon the climatic conditions and resources of the tract. The 2nd fortnight of October is the suitable sowing time was reported by Yadav et al. (1996), Singh et al. (2001) and Panda et al. (2004). The optimum spacing between row to row and plant to plant varying from 30x20 cm (Singh et al., 1985), 60x45 cm (Satyanarayana et al. 1986), 30x10 cm (Gupta, 1988), 45x20 cm (Singh, 1994), 30x15 cm (Kumar et al. 1995) and 45x15 cm (Singh and Chauhan, 2000), depending upon the branching behaviour of the variety.

The Bundelkhand region is the subtropical tract of the state. The climatic conditions and soil types of this region is differ from other part of the state. The 'Mar' and 'Paruwa' soils of this region are more suitable for the cultivation of oil seeds and pulses (Katiyar, 1989). The production and productivity of oil seeds especially rape seed and mustard is very low due to growing of local and un improved varieties, improper management of manures and fertilizers, irrigation without adopting plant protection measures. In other hand, oil seed crops are sown as un irrigated land as pure or as mixed crop with other rabi crops.

The above account adequately demonstrates the justification to balance the demand and supply of oil. We will adopt a technology for increasing the production of oil seeds especially mustard to fulfill its requirement. These points will be kept in mind, it is, therefore, to test different yield deciding factors viz. dates of sowing, planting geometry and varieties in a double field experiment under irrigated condition of Bundelkhand which is the main mustard growing tract of the state.

OBJECTIVES:

The study shall be aimed-

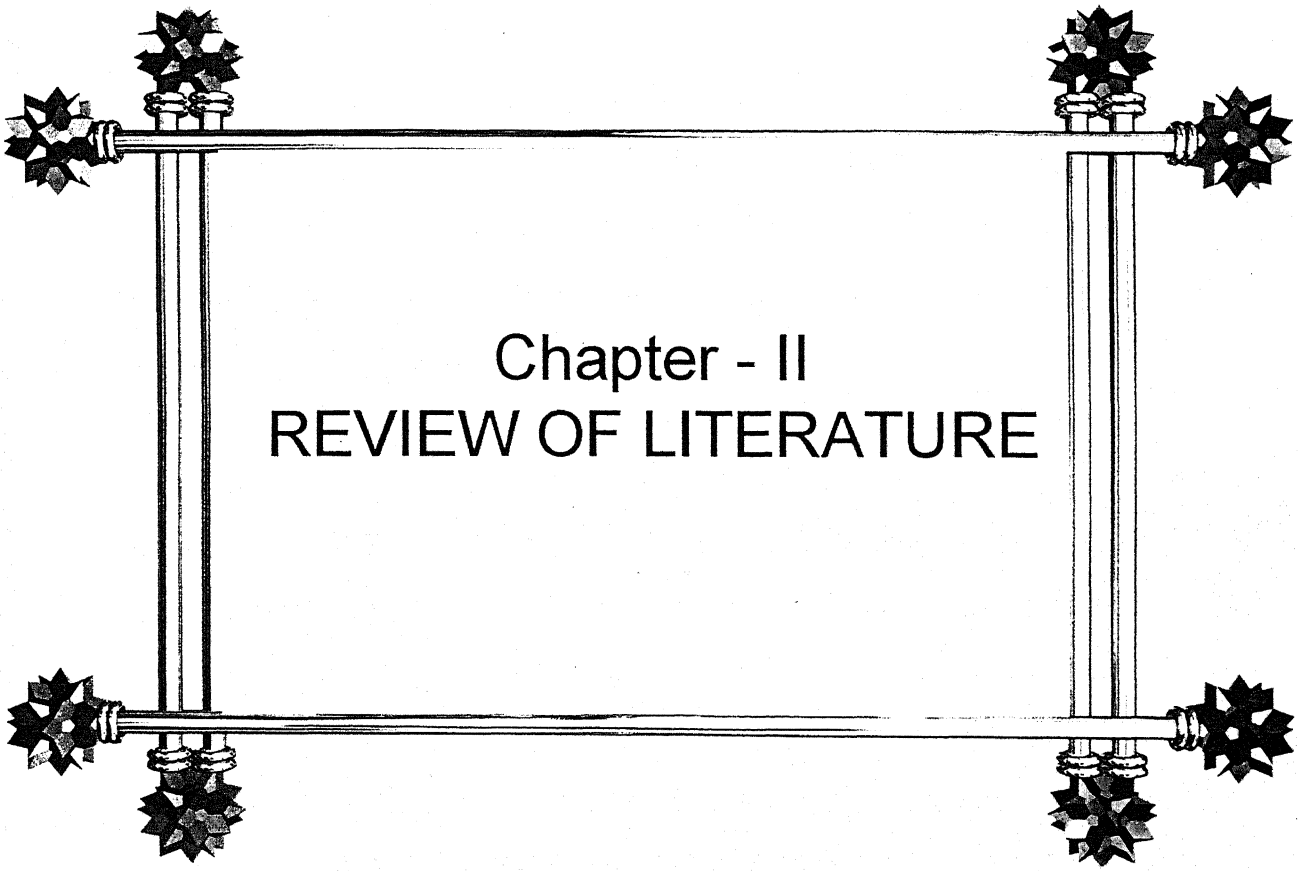
(1) To judge the suitable sowing date for mustard crop.

(2) To determine the suitable planting geometry (Plant population) for mustard crop.

(3) To judge suitable variety of mustard.

(4) To study the effect of sowing dates, planting geometry and varieties on yield and quality of mustard in Irrigated condition in Bundelkhand.

(5) To workout the economics for different treatments.



Chapter - II
REVIEW OF LITERATURE

CHAPTER – II

REVIEW OF LITERATURE

Plant growth has been found to be affected by two types of factors viz. genetical & environmental. Th:ough varietical differences arise usually due to the genetical factor, but more precisely it is due to the interaction between genetical and environmental factors. Constituently varieties may be differ markedly as well as in their yielding ability under different agro climatic conditions and agronomical practices as sowing dates, Planting geometry. A short review of the due pertaining to the work done in India and foreign countries. With reference to effect of sowing dates, planting geometry and varieties on growth, yield and quality of mustard under irrigated condition with special reference to Brassica juncea (L.) Czern & coss in being given below.

1. EFFECT OF SOWING DATES ON GROWTH, YIELD AND QUALITY:

Bisnoi and Singh (1979) reported that the maximum dry matter accumulation/plant was obtained when the crop was sown on October 10 followed by October 30 and November 20, respectively. The growth, dry matter reduced to delayed sowing may be attributed due to sudden dropping temperature particularly during the plant growth period.

Mudhalkar and Ahlawat (1979) studied the crop sown on September 28 and October 13, recorded significantly higher seed yield than late sown crop of October 25 The differences

between the farmer two dates were non significant The higher yield in these two dates may be attributed to increased number of pods/plant as compared to October 25. Early seeding of September 28, recorded significantly lower 1000 grain weight than October 25 and October 13 other plant parameters viz. dry matter production, seed and straw yield/plants, harvest index and seed yield q/ha were maximum on October 13, sowing date.

Patel *et al.* (1980) concluded that 10th & 25th October sowing dates were produced maximum number of pods/plant grain/pod test weight and grain yield over 15 November, 5 December and 25 December. These attributes were non significant among the respected dates of sowing. The average reduction of grain production 35, 60 and 82.5 Kg/day/ha was obtained between 25 October to 15 November, 15 November to 5 December and 5 December to 25 December respectively.

Bhola and Yadav (1982) reported that time of sowing plays an important role in enhancing the yield of crop. The optimum sowing time for different rape seed and mustard crop as under toria first fortnight of September but if wheat is to follow then the end of August or early September is the best time, Brown sarson 25th September to both October, Raya first to 20th October and when sown as mixed crop, the sowing time will be the same as that of the main crop. Taramira through-out month of October and early November.

Gupta and Saini (1982) reported that varying sowing dates as September 1, 11, 21 and Oct 1 caused significantly differed in yield on the basis of three years

result. September 21 sowing resulted in the highest yield on 577 Kg/ha. which was 198 Kg (52%) 59Kg (11%) and 334 Kg (137%) higher than crop planted on September 11 and October 1, respectively. The maturity period was also increased with each delay in sowing. The crop sown September 1 matured in 71 days, but the crop planted October 1 look 86 days maturety.

Singh (1985) found that crop sown on 10 and 25 October significantly affected number of pods/plant, Number of grain/pod, test weight and maximum grain yield than planted on 15 November, 5 December and 25 December respectively. The number of primary & secondary branches/plant were non significantly affected by different sowing dates.

Kurmi and Kalita (1991) obtained the plant height, number of branches/plant, number of siliqua/plant, length of siliqua, seed yield and oil yield per hectare were highest, when the crop was sown on 17 November, Whereas 1000 seed weight, stover yield and oil content (%) were the highest in the crop sown on 2 November.

Jadav and Singh (1992) The pooled data 2 years indicated that the oil content in seeds and oil yield were similar when the crop was sown 18 October, 28 October but decreased significantly when the sowing were delayed up to 17 November. This could be described to improper seed development and oil synthesis in seeds under delayed sowing owing to restricted growth of plants and rise in temperature during the seed development phase.

Chandrakar and Urkurkar (1992) The sowing dates of mustard on 23 November, resulted in significantly more seed yield over later dates but remained at par with sowing on 30 November. Delay in sowing by each week reduced the yield by 6.29% and 47% during 1986 - 1987 and 5%, 17% and 43% during 1987 - 88 as compared with sowing on 23 November respectively. The increase in number of siliqua and 1000 seed weight were reflected by higher seed yield. The seed yield of all the varieties of mustard showed similar yields.

Yadav *et al.* (1994) indicated that early sowing (17 and 27 October) gave significantly higher seed, oil and protein yield and N uptake by seed as compared with late sowing (6 November). Seed, oil and protein yield, N content and N uptake were significantly higher under 2 irrigation scheduled at pre flowering and siliqua development stages than one irrigation.

Dudhane *et al.* (1994) reported that the seed yield of Indian mustard was affected significantly by dates of sowing. Early sowing (10 October) gave significantly higher seed yield than the late sowings during both years. Delayed sowing at an interval of 15 days up to 30 November reduced the seed yield by 8.7, 26.3, 51.2 and 56.3% during 1991 - 92 and 5, 37, 66 and 66.6% during 1992 - 93.

Ghosh (1994) reported that grain and stick yield decreased sharply due to delay in sowing beyond first week of November under this short and mid winter condition of West Bengal. The crop sowing October and early November recorded

significantly higher grain and stick yield than those of the late sown crops. The mid November sown crop showed its superiority to late November and December sown crop. The crop sown in December gave the lowest grain and stick yields.

Yadav *et al.* (1996) reported that higher seed yield was recorded in 17 October sowing, but the yield difference was non significant in respect to 17 and 27 October sowing in both the seasons. This may be due to the prevalence by favourable temperature at sowing time and longer optimum period of crop growth. The late planted crop is subjected to relatively lesser time span available for plant growth and development.

Battar and Aulakh (1999) a field experiment was conducted during 1996 – 97 and 1997 – 98 to study the effect of dates of sowing nitrogen and row spacing on growth, yield attributes and yield of Indian mustard (B. juncea [L.] Czern & coss). The seed yield of Indian mustard was obtained significantly higher when the crop was sown on 25 October than the late sown on 15 November and 5 December. The plant height decreased with delayed sowing, but yield attributing characters pods/plant and secondary branches were highest under early sowing.

Singh *et al.* (2001) evaluated the effect of sowing time on growth and yield of Indian mustard. The significantly superior plant height, branches/plant, siliquae/plant, seeds/siliquae, 1000 seed weight and seed yield were recorded by the sowing of crop on second and third week of October. However delay in

sowing i.e. in fourth week of October and 1st week of November reduced the seed yield of Indian mustard by 14.4 and 24.7% in comparison to sowing third week of October respectively.

Panda *et al.* (2004) suggested that mustard crop sown on 16 October gave significantly more seed yield (1945 Kg/ha) than late sowing dates. In early sowing production phase was comparatively longer which resulted in higher seed yield. The plant height, branches/plant. siliquae/plant, seeds/siliqua 1000 seed weight. Biomass yield and harvest index were also decreased progressively and significantly with delay in sowing as 31 October and 15 November. The oil content of the seed of the crop sown on 16 October was highest (42%) which was at par with the crop sown on 31 October but it was significantly higher than 15 November sown crop.

2. EFFECT OF PLANTING GEOMETRY ON GROWTH, YIELD AND QUALITY :

The plant population and planting space have a great effect on the yield of rape seed mustard. A little work has been done in this aspect.

Singh & Saxena (1963) working at Indian Agricultrural Research Institute, New Delhi, reported that there was slight reduction in the number of branches and number of siliquae with 30x30cm spacing as compared with 45x30 cm and 60x30 cm. It was also found that there was no effect of spacing on number of seeds/siliqua & test weight.

Maini *et al.* (1964) working under patiyala conditions, reported that per plant area of 180 cm^2 was found to be optimum against 90 cm^2 and 360 cm^2 wider spacing slightly reduced both the number of primary and secondary branches. In Punjab conditions, the spacing was found 30x10cm for rape seed & mustard.

Vir and Verma (1980) analysed that significant higher seed yield was obtained under row spacing of 45 cm than 30 and 60 cm row spacings. As regard to number of seeds/pod, 45 and 60 cm row spacings reached at par but length of pod and 1000 seed weight were not affected. More number of pods and seed yield/plant under 60 Cm row spacing may mainly due to better growth and development of individual plant. The total seed yield was more under 45 cm. row spacing due to optimum plant population. Although the maximum number of plants per unit area under 30cm row spacing because of the poor development of individual plants, per hectare yield was reduced. On the other hand, inspite of better development of individual plants under 60 cm row spacing, the seed yield could not compensate with that obtained under 45cm row spacing because 33.3% less plant population in former case.

Shaik khaddar & Bhargawa (1985) Studied that the closer row spacing and higher plant density produced more seed yield over wider row spacing and lower plant density.

Singh *et al.* (1985) indicated that four inter and intra spacings (30x10, 30x20, 60x10 and 60x20 cm) were studied in

rabi 1980 - 81 and 1981 - 82. The maximum seed yield was obtained in 30x20 cm and 60x10 cm row spacings in both the years. All yield attributes improved significantly with the increase in plant space from 300 to 1200 Sq.cm. per plant either in 30x20 or 60x10 cm arrangement during both the years, but number of siliquae/plant was more under plant spacings of 30x20 than under 60x10 cm during both the years.

Gangwar & Kumar (1986) obtained that the plant density levels and spacings did not differ significantly for the seed yield. The 3.33 lakh plants per hectare in 20cm row spacing reduced the seed yield significantly over 2.22 lakh (30cm spacing) and 1.66 lakh (40cm row spacing) plants/ha.

Satyanarayana *et al.* (1986) stated that the plant spacing of 60x40cm gave significantly more seed yield/ha over 60x60cm spacings in the season. It is evident that plant spacing of 60x45 cm, higher seed yield of 1625Kg/ha over 60x60cm spacing 1448 Kg/ha and oil content percent did not differ much due to plant spacings however, closer spacing (60x45cm) produced more oil yield per hectare are owing to increased seed yield/ha.

Singh & Singh (1987) showed that number of siliquae/plant and seed yield/plant reduced markedly with close row spacing of 30cm (higher plant density) as compared to 45 cm and 60 cm row spacings. The reduction in seed yield/plant in close row spacing (higher plant density) may be attributed to competition of growth resources The row spacings of 45 cm

produced significantly higher seed yield than 60cm and 30 cm due to optimum plant population. The improvement in yield attributes with wider row spacings of 60cm could not compensated seed yield due to lower number of plants/unit area.

Gupta & Saini (1988) obtained that 60cm row spacing recorded higher yield than the spacings of 30 cm and 45 cm.

Gupta (1988) showed that wider spacing of 30x10 cm and 22.5x10 cm produced more branches and siliquae/plant that closer spacings of 15x10 and 10x10 cm and broadcast the planting geometry of 30x10cm spacing recorded highest 1000 seed weight but the differences were marked over 15x10 cm only. The seed yield q/ha, however, showed reverse trend being higher with close spacing.

Mishra and Rana (1992) at Lakhaoti found that widering of row spacing (30 to 45 and 60cm) reduced the plant height and increased number of branches, though the effect was not marked. Seed yield/plant decreased significantly by increasing row spacing due to reduction in plant population. The yield attributes viz. number of siliquae/plant and 1000 seed weight increased with the widering of rows but the increase was non significant. Oil content remained unaffected by row spacings. Improvement in yield attributes might be due to reduced competition among the crop plants due to the low plant population on account of widering of row spacing.

Chauhan *et al.* (1992) conducted that row spacing of 30cm in rape (Floria) gave more grain and straw yields than other

treatments. Grain and straw yields increasing by 5.9 and 5.2 percent over 40cm and 21.1 and 10.0 percent over 20 cm. similar trend was observed for grain weight/plant and 1000 seed weight. Row spacing did not affected the plant height but number of branches and dry weight/plant were affected up to 40cm spacing. Increase in oil and cake yields at 30cm was more due to higher crop yield as compared to 20cm and 40 cm row spacings.

Chauhan *et al.* (1993) suggested that yield attributes like number and weight of siliquae, grain weight/plant and 1000 seed weight were significantly affected under 30cm row spacing. The height of plant, number of primary branches and dry weight/plant were significantly increased under 30 cm row spacing over 20 cm and 40 cm. This may be due to more transformation of photosynthetes for reproductive parts.

Sharma (1993) reported that row spacing 37.5 cm produced markedly higher number of seeds/siliqua, 1000 seed weight and seed yield (18.47 q/ha) than 45 cm and 22.5 cm respectively.

Ghosh (1994) found that high plant density (3.33 lakh plants/ha) recorded the highest grain yield which was at par with medium plant density (2.22 lakh plants/ha) but significantly superior to plant density (1.67 lakh plants/ha). Similarly, high plant density resulted in the highest stover yield which was significantly superior to both medium and low plant densities. The maximum yield was recorded at high plant density which

was at par with medium and was significant with low plant density due to higher plants.

Singh (1994) conducted that growth yield attributes such as height of plant, Fresh & dry weight/plant, number of branches per plant. Number of siliquae/plant, Weight of siliquae/plant and seed weight/plant were found significantly maximum in wider plant density (60x20 cm), while the seed yield (q/ha) was observed significantly maximum in medium plant density (45x20cm) over wider (60x20 cm) and lower (30x20 cm) plant densities due to optimum number of plants/unit area.

Singh (1995) suggested that growth characters such as height of main shoot, Number of leaves/plant, Fresh and dry weight/plant, Number of primary, secondary and tertiary branches/plant were recorded significantly maximum in row spacing 60cm over 45 cm and 30 cm respectively.

Bhan *et al.* (1995) reported that plant spacing 15 cm was at par with 10 cm and 20cm spacings and given 39.8 to 51.8 percent more seed yield than 25 cm and 30 cm row spacings respectively. The increase in seed yield in medium spacing was mainly due to optimum number of plants/ha. The plant spaced widely (30cm) produced more siliquae/plant than closer (No thinning) and medium plant spacings. No thinning treatment was not found favourable to yield attributes and yield, though the plant stand, height of plant and maturity were observed higher under this treatment.

Kumar *et al.* (1995) has reviewed at Pant Nagar that wider planting geometry in Indian rape was increased pod bearing capacity and productivity of individual plants. The higher plant population compensated this effect and higher total seed and oil yield/ha was recorded at 2.22 lakh plants/ha (30x15 cm). The lowest seed yield was recorded in crop sown in lines at 30 cm without thinning. The highest number of branches/plant in wider plant density, the seed yield was maximum at 2.2 lakh plants/ha this may be justified as the improvement in yield attributes. At lower plant density failed to compensate yield for lower plants/unit area. Oil content was increased with increasing plant densities.

Ali *et al.* (1996) reported from Dhaka (Bangla Desh) and found the effect of different levels of nitrogen, sulphur and plant density on yield attributes oil and protein content of rape seed. Nitrogen up to 120 Kg/ha increased the yield components seed and stover yield/ha and harvest index, yield attributes and seed and stover yield harvest index progressively increased with the increase in level of sulphur. Lower plant density increased the number of siliquae/M^2, Seed and stover yield/ha and harvest index. Oil content was related to protein content in seed irrespective to different levels of nitrogen, sulphur and plant density.

Sharma *et al* (1998) a studied the effect of crop geometry and nitrogen levels on yield and its attributes of Brassica species. The RH-819 and RH-30 Cvs of Indian mustard were at

par but both gave significantly higher seed yield over Cv. TCH-2 of toria. The crop geometry had no significant effect on seed yield and its attributes. Nitrogen treatments increased significantly the seed yield and its attributes.

Singh and Chauhan (2000) reported that plant spacing 45x15 cm was found most suitable and economic in respect to seed production (q/ha) and net profit (q/ha) base over other plant spaces such as 30x15 cm and 60x15 cm respectively. Though the growth characters as height of main shoot, dry matter production/plant, number of branches/plant and all the yield attributes were recorded maximum in wider plants space i.e. 60x15 cm due to more utilization of sun light nutrients and space. The seed yield (q/ha) and Net profit (Rs/ha) were maximum in 45x15 cm plant space due to normal plant growth and optimum number of plant/unit area.

Mahan and Singh (2003) reported that plant density 60x15 cm produced significantly maximum growth characters such as height of main shoot, fresh and dry weight/plant and number of branches/plant. The yield attributes were also maximum in respected plant density i.e. 60x15 cm, followed by 50x15 cm., 40x15 cm and 30x15 cm plant densities respectively. The biomass production and seed yield (q/ha) in 50x15cm space produced 8.08, 8.15 and 23.9 percent and also occurred Rs. 1855.98, Rs. 1867.16 and Rs. 5284.66/ha as additional net income (Rs/ha) over 60x15 cm, 40x15 cm and 30x15 cm plant spaces respectively.

Memoh *et al.* (2004) an experiment was conducted during 2000-2001 to study yield and quality responses to plant densities of 17500 plants/ha (row spacing of 54.5 cm) 97500 plants/ha, (row spacing 38 cm) and 127500 plants/ha (row spacing of 29cm) to winter oil seed rape (Brassica napus L.) cultivar 'HD 605' at Zhejiang University Farm, China. Dry matter accumulation of plant decreased with increasing plant density, number of the primary, secondary branches were also decreased with increasing plant density (18.2% and 38.7%). Weight (3.33 – 3.52 mg), varied among in seed yield was respectively realized with increasing plant density from 67500 to 97500 plants/ha and from 97500 to 127500 plants/ha; The seed oil content (42.26 – 44.91%) was significantly more while fatty acid composition and glucosenolate content of oil seed rape was un affected by plant density.

Kumar *et al.* (2004) studied that crop geometry of 30x10 cm significantly enhanced the plant height, while 45 cm x 10 cm crop geometry for branches/plant was significantly superior over 30 cm x 10 cm crop geometry. The result indicated that closer row spacing (30 cm) favoured more varietal growth of the plant, while wider row spacing (45 cm) was more favourable for total plant growth. Among the yield attributes, only siliquae/plant were significantly higher in wider row (45 cm) spacing with contributed towards realizing higher seed yield as compared to narrow row spacing (30 cm). No significant

difference in oil content and oil yield was obtained in both the crop geometries.

Singh and Ram (2005) suggested that all the growth characters such as height of main shoot, number of functional leaves/plant, Fresh and dry weight/plant and number of branches/plant and yield contributing characters. As number siliquae/plant, weight of siliquae/plant, number of seeds/siliqua, weight of seeds/plant and weight of 1000 seed were recorded maximum in wider row space i.e. 50 cm due to more space/plant and more utilization of nutrients soil moisture and sun light over other closer spacings. The seed yield (q/ha) was recorded significantly maximum 45 cm row space over 50 cm, 40 cm and 35 cm row spaces respectively. The prescribed row space i.e. 45 cm produced maximum seed yield due to optimum plants/unit area, over wider space and in closer spaces, the plants were not survive properly due to dense plant population and would not cover seed yield/unit area.

3.EFFECT OF VARIETIES ON GROWTH, YIELD AND QUALITY:

Pathak and Verma (1965) reported that T-59 has given about 17% higher seed yield than the local and compares favourably in respect of yield and oil content with already recommended variety T-16, due to its very attractive seed size.

Bokkatia and Sandhu (1973) showed that T-6342 gave highest three year average seed yield of 838 Kg per hectare followed by rai 237 and rai 236 with 807 and 769 Kg per hectare seed yield respectively.

Mehrotra *et al.* (1976) noted that there was considerable variation in branching, number of siliquae and 1000 seeds weight while number of seed per siliquae showed little variation. Varuna, produced the boldest seeds, number of siliquae and branches per plant which were positively correlated with seed yield and branching.

Bhola and Yadav (1982) observed that the following are the recommended varieties of toria (Sangam 15 q/ha), brown sarson (BSH-1, 16 q/ha, raya (Prakash 38 q/ha) and RH-30) best suitable for mixed cropping in wheat, barley and Gram.

Saini (1982) showed the improved high yielding varieties of mustard are Varuna, Prakash, RLM-198 and RLM-514 for improved technology and cultural practices.

Lamba *et al.* (1982) defined that RLM-198 is a mustard variety recommended for cultivation at all India level in 1981. It gives 44 percent higher yield than varuna. Its yield potential under excellent conditions in 38 q/hectare.

Rai (1982) observed that the commercial varieties of Brown sarson, Pusa Kalyani, BS-2, BSH-1 (Sarson of Haryana), Suphala, BS-70 which are given maximum yield. Pusa Kalyani is a loteni type of Brown sarson and takes 125-130 days for its maturity and yield potential of 15-25 quintal per hectare.

Bhajan *et al.* (1984) found that Krishna and Kranti varieties were 17.25 percent and 14.47 percent respectively. Superior in seed yield over the variety Varuna.

Rathi and Tripathi (1984) noted the highest yield of Varuna (40.26 q/ha).They also reported 1138.9 pods per plant, 68.6 g seed per plant yield and 5.29 g per 1000 seed weight.

Chaudhary and Bandopadhyay (1984) observed that 6 varieties of B. juncea gave two years average seed yield of 0.62 to 1.04 t/ha. The highest being inRW-351 which was closely followed by TM-7 with 1.02 t/ha.

Saini *et al.* (1985) analysed that yellow sarson (B.napus) Cv Basant has a plant height of 135 cm, flowers in 32 days and mature in 132 days, Basant and the standard cultivar DYS-1 gave oil contents of 47 and 44 percent respectively.

Dixit and Srivastava (1989) found that mustard variety Vaibhav was superior in seed yield and it increased 20.20 and 9.49 percent more seed yield over the varieties Varuna and Kranti respectively.

Prasad *et al.* (1989) studied that varieties Krishna and Kranti being of par and gave higher seed yield with 5 percent and 15.54 percent respectively over Varuna. The higher yield of these varieties were due to the more number of siliquae, seeds per plant and 1000 seed weight.

Sharma *et al.* (1991) has reviewed that veriety Kranti produced significantly higher seed yield over the varieties Pusa bold and Varuna. The Pusa bold and Varuna varieties were at par but these were significantly, superior to Krishna. The higher seed

yield in CV Kranti was due to significant higher number of branches and number of siliquae per plant.

Yadav *et al.* (1992) obtained that the CV T-59 gave highest seed yield followed by RH-30, RLM198 and RLM-514. The RH-30 showed average mean performance with above were responsefor days to maturity and number of siliquae per plant but it had below average performance with plant height.

Tomar *et al.* (1992) stated that B-85 and RLM-514 were out yielded than Varuna during the pooled year.

Singh & Kumar (1992) suggested that variety Varuna gave more seed yield (12.53 q/ha) over the varieties Vardan (16.90 q/ha), Laha (16.13 q/ha) and Rohini (15.93 q/ha) due to higher number of siliquae per plant and 1000 seed weight.

Gaur and Bansal (1992) concluded that Pusa bold mustard variety gave the maximum seed yield being 7.7 and 1.7 percent higher than T-59 and Kranti respectively. The investigated seed yields Pusa bold was showed to improved yield attributes like single plant seed yield and test weight of seed. Bold seed and higher test weight of Pusa bold was the varietal character resulted in higher seed yield per plant.

Kumar *et al.* (1993) working the mustard varieties were observed in respect to yield attributes such as height, number of siliqua were recorded more in HC-2, however maximum number of seeds/siliquae and longest length of siliquae are observed in Cv No. 20-7. Regarding in 1000 seeds

weight, the lowest and highest values was recorded in N.20-7 and RH-30 varieties respectively.

Punia *et al.* (1993) stated that the varieties differed significantly for number of siliquae per plant, single plant seed yield, test weight, seed and oil yields, Varuna mustard gave the highest number of siliqua per plant, Single seed yield and test weight as well as seed and oil yields than kranti mustard.

Yadav *et al.* (1994) reported among the 4 CVS tested and Vaibhav performed best with a yield of 13.3 and 14.4 q/ha during both years respectively. Whereas Varuna gave the least yield over other varieties. The variety Vardan was at par with Rohini and Rohini was statistically superior to Varuna but inferior to Vaibhav.

Singh (1994) noted that the variety Vaibhav was found high yielder and economic over the varieties RK-9001, Vardan, Varuna, Rohini, Pusa bold, RH-30, RLM-188, RLM-198, Kranti, RL-18 and Seeta varieties respectively. The growth character of variety Vaibhav such as number of branches per plant, dry matter per plant, Length of siliquae, weight of siliquae/plant and weight of seed/plant were significantly maximum over other varieties of Mustard.

Tomar *et al.* (1996) reported that variety Varuna, was significantly superior over Pusa bold, Prakash and RH-8113, varieties in respect to number of siliquae/plant 1000 seed weight, seed and oil yield per hectare.

Thakuria and Gogoi (1996) conducted that three varieties could not show any significant effect on growth, yield attributes and yield. However Varuna recorded significantly higher 1000 seed weight than TM-4 during 1989-90 and both TM-2 and TM-4 during 1990-91. This might be due to bold seed size of Varuna.

Bora (1997) found that Varuna Indian mustard recorded the highest seed yield which was significantly higher than those of rape seed 'M-27' and 'TS-29'. The branches/plant siliquae/plant, 1000 seed weight were more in Varuna, Though the rape seed varieties were superior to the mustard variety in respect of seed oil content. The trend of oil seed was similar to that of seed yield.

Gurjar & Chauhan (1997) studied that 'Pusa bold' and kranti were at par in influencing plant height, leaves and primary branches/plant significantly. However all these attributes were higher in 'Pusa bold' except plant height, which was higher in 'Kranti'. Secondary branches and siliquae/plant, seeds/siliquae were significantly higher in 'Pusa bold' than in Kranti. Although the seed yield was higher in 'Pusa bold' than Kranti but not the significant level. It shows that there was not much difference among these varieties for above trends in Harsi command area.

Singh & Singh (1998) Found that Indian mustard 'PR-45' produced significantly highest seed yield followed by 'Kranti' and Varuna. However 'Krishna' was most poor for seed yield. The

'PR-45' gave 6.67, 17.02 and 41.46% more seed yield over kranti Varuna and Krishna respectively. More yield in PR-45 was mainly due to maximum expression of yield attributes like siliquae/plant, siliqua length, seeds/siliqua and 1000 seed weight.

Kumar *et al.* (2000) among genotype CVS 52 and RH-8814 had significantly more in number of total branches than other genotypes. CV GSH-1 had significantly lesser number of siliquae on main shoot as compared to genotypes. CVS, CS 52, Kranti, GJM 9056. The RH-8814 were at par and had significantly, higher number of siliquae on main shoot than CV, RH-30. The siliqua length of GSH-1 genotypes was significantly more than other genotypes. The Brassica juncea cultivars did not differ significantly in respect of seed per plant were as Brassica napus genotypes recorded the lowest seed yield/plant.

Singh *et al.* (2001) found that 'Pusa bold' and T-59 were statistically at par and found significantly superior to local cultivar in respect of yield components except plant height. It might be due to genetic charactership of the local cultivar. The maximum yield, attributing characters viz. branches/plant, siliquae/plant, Seed and 1000 seeds weight, were recorded in Pusa bold which resulted in the maximum seed yield, accounting for an increase of 29% over local cultivar.

Bhalend Rao (2001) reported that 'Pusa bold' Indian mustard recorded significantly higher seed yield than Varuna. The average increase number of 15.64% more seed yield in

respected variety. The significantly increase in yield was mainly owing to higher values of yield attributes and oil yield in Pusa bold than Varuna.

Mangat Ram *et al.* (2002) reported that variety RH-30 produced significantly higher seed yield than the varieties RH-8113 and Varuna. The respected variety RH-30 increased 17% and 45% more value over RH-8113 and Varuna varieties respectively. This was probably due to higher 1000 seed weight whereas the yield advantage over Varuna could be attributed to greater number of siliquae/plant and higher 1000 seed weight.

Singh and Singh (2002) reported that the among Indian mustard varieties Narendra rai -1 and Varuna gave significantly higher seed yield 20.5 q/ha and 20.1 q/ha respectively, than Vardan (17.6 q/ha) owing to better expression number of siliqua/plant, number of seeds/siliqua, test weight, harvest index and stover yield and consequently gave higher net return and net return/rupee investment (Rs. 11073/ha and 0.91). The growth parameters such as plant height and number of primary and secondary branches/plant were in similar trend. Narendra rai-1 recorded significantly higher uptake to sulphur (14.1 and 13.1 Kg/ha) over Vardan (13.9 and 12.6 Kg/ha) and Varuna (11.4 and 10.6 Kg/ha) during both the years. The varuna was superior in oil as in protein content and was significantly superior to Vardan and Narendra rai -1. It may be due to genetic characters of various varieties.

Dwivedi and Singh (2002) tested four varieties of mustard as 'Varuna', Vaibhav, Vardan and Rohini and reported that variety Varuna produced significantly maximum 4.58 12.97 and 14.81 percent more seed yield over the varieties Vaibhav, Vardan and Rohini respectively. The variety Varuna increased seed yield significantly with increasing yield attributes as number of siliquae/plant, weight of siliquae/plant, length of siliqua/plant, number of seeds/siliqua, weight of seeds/plant and 1000 seeds weight. The Varuna varieties also produced more number of branches/plant and dry matter accumulation/plant.

Virya and Singh (2003) concluded that height of main shoot, fresh and dry weight/plant and number of primary and tertiary branches/plant were recorded significantly more in 'Pusa bold' but number of functional leaves/plant were found more in variety 'Varuna' followed by other varieties. The yield attributes as number of siliquae/plant, weight of siliquae/plant weight of seeds/plant and weight of 1000 seeds were significantly in variety Varuna but number of seeds/siliqua was maximum in Pusa bold. The pusa bold variety produced 5.16, 10.08 and 16.19 percent more seed yield and Rs. 1310.65, Rs. 2520.82 and Rs. 4033.46/ha as additional net income, over the varieties as Laxmi, Varuna and Rohini respectively.

Mangat Ram *et al.* (2003) suggested that varieties Varuna and RH-30 were at par and gave significant higher protein content than RH-8113, but protein yield was significantly higher in RH-30.

Panda *et al.* (2004) the variety Pusa bold gave significantly higher seed yield (1527 Kg/ha) than 'SEJ-2' (1389 Kg/ha). The higher seed yield with pusa bold was obtained owing to increase in yield attributing characters viz. siliquae/plant, seed/siliqua and 1000 seed weight.

Kumar *et al.* (2004) conducted the RB-9901 variety was ignificantly superior to RH-30 and Laxmi for growth components except branches/plant, yield parameters and seed yield. It might be due to genetic characters in RB-9901 variety. The better yield attributing characters in RB-9901 resulted in the maximum seed yield accounting for 14.3 and 5.2% higher yield over RH-30 and Laxmi respectively. Oil content (%) was significantly better in RB-9901 and oil yield also followed the trend of seed yield.

Katiyar *et al.* (2005) Pusa bold was a land mark variety originally released for eastern India in 1984. But the variety is most widely adopted and well adjusted to the condition of North & North West in grown by large number of farmers the seed yield is also attractive and bold.

Pusa Jagannath variety is also result of a cross between one significantly synthesized Indian mustard material by crossing the progenitor species as in Pusa Agrani and Varuna, a natural Indian mustard released in 1999. The variety is bold grained and tolerant to diseases.

Singh & Ram (2005) recorded that growth characters such as height of main shoot Fresh and dry weight/plant were

significantly and number of leaves/plant and branches/plant were non significantly produced maximum in Varuna variety followed by other varieties. The variety Varuna increased 18.43, 19.25 and 31.39% additional seed yield over the other varieties as Kranti, Shyam 101 and Jagannath respectively. The seed yield owing is due to more number of siliquae/plant, weight of siliquae/plant, length of siliqua, number of seeds/siliqua, weight of seeds/plant and weight of 1000 seeds.

I. EFFECT OF D X G INTERACTION ON GROWTH AND YIELD:

Reddy and Narayana (1994) in a field trial in winter (1990-91) at Jgitial Andhra Pradesh mustard (B. juncea) Cv. Varuna was sown on 31 October or 10 or 20 November and spaced at 20x10, 30x10 or 40x10 Cm. seed yield decreased with delay in sowing date after 31 October. It was not affected by the different spacings.

Shivani *et al.* (2002) a field experiment was winter (rabi) seasons of 1999/2000 and 2000/2001 in Gangtok, Sikkim, India to study the response of Indian mustard (Brassica juncea) to sowing date and row spacing. Sowing on 25 September and 5 October recorded significantly higher number of branches, seeds/siliquae, siliquae/plant and 1000 seed weight, seed yield than on 15 October, 25 October and 4 November. Seed yield decreased progressively with delay in planting. However seed yield was significantly influenced by different row spacing. Significantly higher seed yield/ha was recorded with 30 and 45 cm spacing than 60 cm spacing. A row spacing of 45 cm was

found suitable for crop sown on 25 September and 5 October, whole 30 cm was optimum for Indian mustard sown beyond 5 October. Oil content was significantly influenced by sowing date but remained unaffected due to variation in row spacing.

II. EFFECT OF D X V INTERACTION ON GROWTH AND YIELD:

Narang & Singh (1987) Showed that the possibility to obtain 9-10 q/ha yield of mustard even under late sowing in third week of November with varieties like RLM 514, RLM 198 and RLM 240. Amongst the variety RLM 514 out yielded by 2.3 – 2.5 q/ha at moderately late (First week of November) and by 0.70 – 0.90 q/ha due to its early flowering and podding the higher siliqua bearing capacity and bolder seeds such high yield under late sown condition suggest the scope for adoption of Indian mustard and second in sequence to kharif cereals (Paddy, maize, pearl millet) and Nitrogen levels. Delay in sowing from 10th October to 30 October and 20th November significantly reduced seed yield/plant and seed yield in q/ha. The October 10 sowing produced more seed yield q/ha. Which was 23.7 percent and 49.5 percent more over October 30 and November 20. The test weight significantly better in October 30, sowing than October 10 and November 20, sowing respectively. In late sowing, seed formation seems to have adversely affected due to sudden drop in temperature.

Pouran *et al.* (2000) The effect of sowing dates (8 and 23 October and 8 November) on 6 Indian mustard (Brassica juncea) cultivars (Vardan, Varuna, Sita, GM-1, Pusa blold,

Kranti) and 3 toria (Brassica compestris, Var, Divya) were evaluated in a field experiment conducted during rabi of 1993, 1994 and 1995 in Madhhra, Andhra Pradesh, India. Sowing in the first week of October gave a significantly higher yield (1106 Kg/ha) compared to sowing on 23 October and 8 November (860 and 646 Kg/ha) respectively. The reduction in yield was 28 and 33% when the crop was sown on 23 October and 8 November respectively. Delaying sowing after 8 October resulted in significant reductions in number of branches/plants siliqiae/plant and yield. Among the mustard cultivars, GM-1, gave the highest seed yield (1050 Kg/ha) followed by Kranti and Pusa bold (790 and 760 Kg/ha) respectively. Varuna and Sita produced comparable yields (680 and 610 Kg/ha) respectively. The highest number of siliquae per plant (180) was also noted in GM-1 in the toria group. PT-303 recorded a significantly higher yield (550Kg/ha) compared with Bhawani and Divya (480 and 450 Kg/ha) respectively.

Punia *et al.* (2002) The experiment was conducted at P.A.V. Regional Research Station Bhatinda Punjab tested varieties of mustard viz. RGN-13, RGN-15, RL-1359, Varuna, PCR-10 and PK-9903 and five varieties recommended for Haryana viz. RH-8812, RH-30, RH-781, RH-819, RH-8113, were also included and three dates of sowing as October 10, October 25 and November 10. Among varieties RH-30, produced maximum seed yield. Whereas RH-8113 gave minimum yield in October 10 planting RGN-13 yielded maximum and statistically at par with

RH-30 and RL-1359, but in October 25, planting BR-157 yielded maximum which was statistically at par with RH-30, RL-1359 and RH-8812. When sowing was delayed up to November 10, (30.5) and (24.3) percent reduction in seed yield was observed as compared to October 10 and October 25 planted crop. In late sown condition variety RH-30, RGN-13 and PBR-157.

III. EFFECT OF G X V INTERACTION ON GROWTH AND YIELD:

Sharma *et al.* (1997) showed from Hissar, effect of crop geometry and nitrogen levels on quality and oil yield of Brassica species Cv. TCH-2 of toria had higher oil content and lower protein content than RH-30 and RH-819. The tested two crop geometry 30x15 and 30x60 cm. The crop geometry 30x60 cm produced higher grain yield over 30x15 cm.

Gurjar & Chauhan (1997) reported on the effect of two varieties at two spacings and five fertility levels on Indian mustard. Pusa bold and Kranti were found at par in yield. Nitrogen @ 50 Kg/ha 33 P^2O^5 @ ha gave significantly more height of plant, number of leaves and seed/siliqua. However primary and secondary branches, siliqua/plant were significantly higher under 30 cm spacing that 45cm spacing.

Anal *et al.* (2002) field experiment were conducted during the rabi season of 1996-97 and 1997-98 in Imphal, Manipur, India with broad leaf mustard (Brassica juncea) cultivars Hanggam Amubi, Hanggam Anguobi and Hanggam Anganbi and spacing. The spacing treatments were 66.6 x 66.6, 50x50, 50x40, 40x40, 50x25, 40x25 and 25x25 cm. Hanggam

Anguobi (V_2) showed superiority in growth characters and yield, wider spacing (66.6 x 66.6 cm) resulted maximum number of leaves, fresh weight of leaves and fresh weight of aorial stem /plant, the highest yield (4.31.98 q/ha) was recorded with the closest spacing of 25x25 cm. Hanggam Amubi (V_2) and Hanggam Angaubi (V_3) performed better in all the physiological growth parameters. Closer spacing recorded higher leaf area index (LAI) and leaf area ratio but lower relative growth rate and net assimilation rate irrespective of year and stages. All the physiological growth characters except LAI decreased progressively with the advancement of time.

Meitei *et al.* (2001) the effect of spacing (66.6x66.6, 50x50, 50x40, 40x40, 50x25, 40x25, 40x25 and 25x25 cm) on the performance of Brassica juncea Var. rugosa, cultivars, Hanggam Amubi, Hanggam Angoubi and Hanggam Anganbi were studied in Impal, Manipur, India during the rabi seasons of 1996-97 and 1997-98. Various physiological parameters was evaluated at 15 day intervals from 20 days after transplanting (DAT). Hanggam Angoubi recorded the greatest leaf area index at 20 (0.69), 35 (1.56), 50 (1.88) and 65 DAT (2.47) The highest net assimilation ratio at 30-35 and 35-50 DAT (0.29 and 0.21 per day respectively) was observed in Hanggam Angoubi. A spacing of 25x25 cm resulted in the highest leaf area index at 20, 35, 50, 65 DAT (0.68, 1.74, 1.86 and 2.25, respectively) spacing at 66.6 x 66.6 cm resulted in the highest net assimilation net at (0.39g/day). The cultivars did not significantly vary in terms of

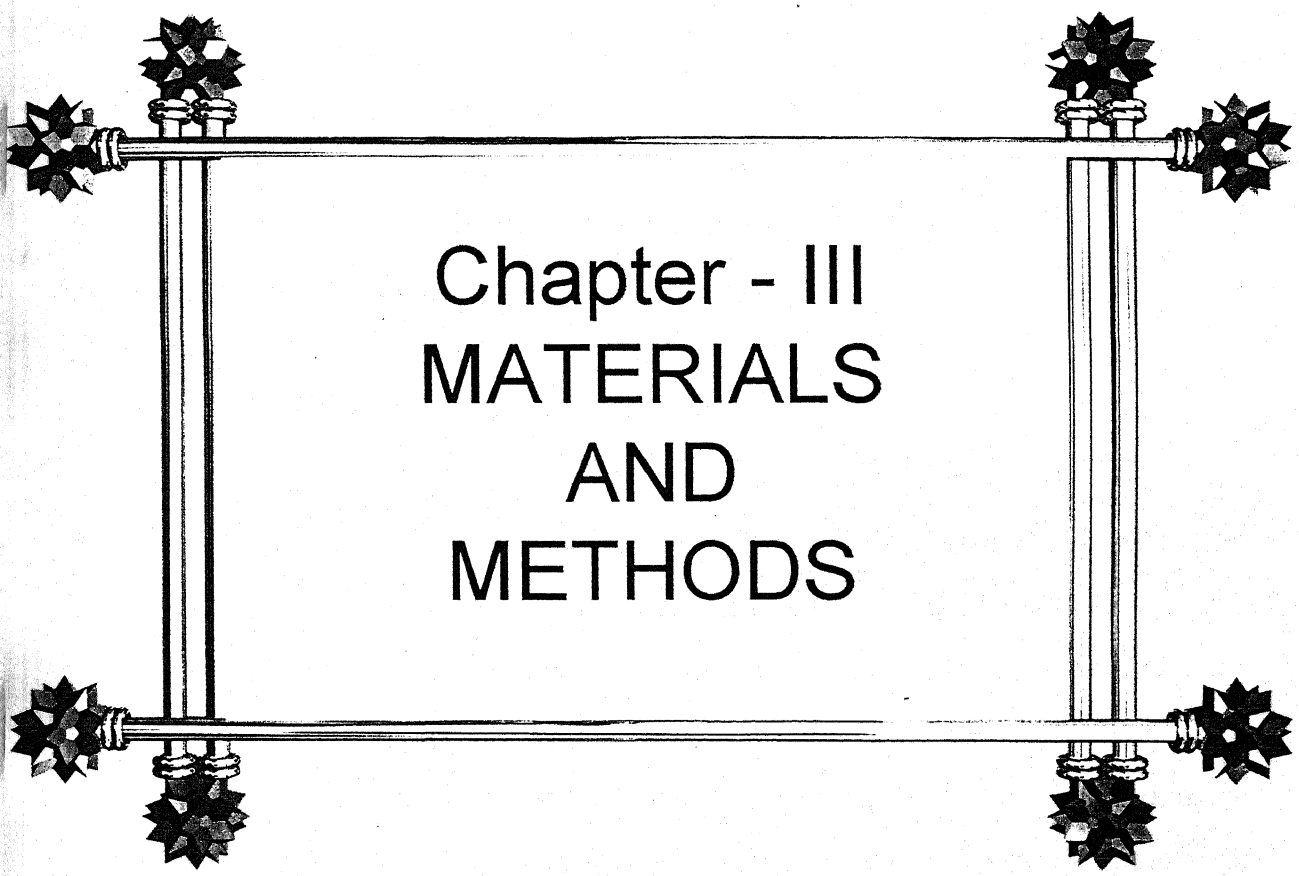
leaf area ratio. The physiological parameters except leaf area index decreased as the crops mustard.

IV.EFFECT OF DxGxV INTERACTION ON GROWTH AND YIELD:

Khan and Tak (2002) Six genotypes of Indian mustard namely Pusa bold and RLM-619 of mid early, RL-1359 and RH-30 of medium Prakash and RLM-198 or late maturity groups, were evaluated under 3 dates of sowing (5 and 20 October and 5 November) and 3 spacings (30, 40 and 50 cm) on a clay loam soil with high holding water capacity at RS Pura, Jammu, India during rabi 1993-94 and 1994-95. In all maturity groups of Indian mustard. The optimum date of sowing was 20 October recorded higher seed yield compared to 5 October and 5 November sowing. Sowing at 30 cm spacing offered substantially higher yield than 40cm and 50 cm spacing.

Kumar *et al.* (2005) a field experiment was conducted during 1999-2001 at Bawal Haryana to study comparative performance of tetralocular Indian mustard (Brassica juncea L. Czernj and coss on) variety 'PB-9901' in comparison with bilocular traditional cultivars 'RH-30' and Laximi different planting times and crop geometries in light textured irrigated soils of semi arid climate, crop planting on 14 and 21 october took significantly more days to 50% flowering (55 - 57) and maturity (154 and 156) compared to 7 October planting. The maximum seed yield (2.98 tonnes/ha) and yield contributing parameters (branches/plant, siliquae on main shoot and siliquae/plant) were recorded when the crop was planted by 8.5

and 3.5% over that planted on 7 and 14 October respectively. Overall 'RB-9901' was found superior for seed yield (3.05 tonnes/ha), oil yield (1.26 tonnes/ha) and yield attributes viz siliquae on main shoot (83) siliquae/plant (626) and seeds/siliqua (19)and out yield RH-30 and Laxmi by a margin of 14.3 and 5.2% respectively. The crop geometry of 45 cm x 10cm was found optimum for all the varieties. The interaction effectes revealed that performance of RH-30 was significantly superior when planted on 21 October, whereas Laxmi and RB-9901 were equally better under both the sowing dates of 14 and21 October.



Chapter - III
MATERIALS AND METHODS

CHAPTER – III

MATERIALS AND METHODS

The present investigation "Effect of Sowing dates Planting Geometry and Varieties on Growth, Yield and quality of Mustard (**Brassica juncea** coss.)" under irrigated condition was conducted during rabi season 2003-04 and 2004-05 along with climatic data and edaphic conditions prevailed in the crop seasons are presented in this chapter.

EXPERIMENTAL SITE:

The field experiments were conducted at Brahmanand Mahavidyalaya Rath, (Hamirpur) U.P.. The research farm is situated in the southern part of Uttar Pradesh in Bundelkhand region. The field has assured irrigation facilities and good drainage with moderate slope in one direction from east to west.

GEOGRAPHICAL SITUATION:

Geographically, the experimental station is located at a latitude of 79.7 east and longitude of 25.5 north at on elevation of 526ft. from Sea level.

CLIMATE AND SEASON:

Bundelkhand has subtropical climate with extreme hot days in summer and cold in winter. The average annual rainfall varies between 800-900 mm which is mostly received during last June to September months while the small fraction of rainfall was also experienced during winter months. The mean monthly temperature (Maximum), relative humidity (Maximum and

Minimum) and total rainfall as record at the meteorological observatory at the farm are given table -1 and 2 and depicted in Fig.1 and 2.

Table-1: Meteorological data during the crop season 2003-04 and 2004 - 05.

period standard weekly 2003-04	Temperature (°C)		Relative humidity (%)		Rain-fall (mm)	Wind velocity (Km/hr)	Sun shine (hrs.)	Evepor-ation (mm)
	Max.	Min.	I	II				
1	2	3	4	5	6	7	8	9
2003								
46	29.3	11.2	90	47	0.0	2.1	8.6	2.9
47	27.7	12.0	89	51	0.0	3.0	7.8	2.9
48	25.7	6.7	88	52	0.0	2.5	8.8	2.6
49	27.6	7.9	90	42	0.0	2.6	9.1	2.7
50	28.9	10.1	90	37	0.0	3.0	8.6	2.3
51	21.2	9.1	91	64	0.0	2.8	5.0	1.5
52	17.3	5.5	93	62	0.0	4.5	4.9	1.6
2004								
1 Jan.	13.0	03.9	95	67	000.0	02.1	03.2	01.1
2	22.4	06.4	95	50	000.0	02.3	08.2	01.5
3	22.1	08.2	95	56	06.8	04.2	06.3	01.6
4	19.6	06.6	96	58	001.2	03.8	06.1	01.6
5	21.2	06.4	95	50	000.0	04.0	08.1	01.9
6	.24.0	05.1	93	50		03.2	10.1	02.9

7	25.6	08.0	93	52	–	03.3	09.5	02.6
8	29.8	09.9	89	38	–	02.8	09.9	03.3
9	31.3	10.6	84	42	–	03.6	10.3	03.8
10	32.0	12.3	84	36	–	02.9	09.8	04.0
11	36.4	14.5	79	28	–	03.2	10.1	04.5
12	38.8	17.2	67	25	–	05.1	10.2	06.6
13	36.7	15.1	77	20	–	03.5	10.1	06.7
Table-2 **2004**								
46	31.3	11.0	82	27	000.0	03.1	09.1	03.0
47	31.6	10.2	81	27	001.2	02.5	08.3	03.1
48	28.9	10.5	79	33	000.0	02.7	08.3	02.8
49	26.4	08.5	84	32	000.0	02.9	08.5	02.7
50	25.2	06.8	82	36	000.0	02.4	07.7	02.4
51	23.7	06.8	88	39	000.0	02.9	06.7	01.9
52	20.7	06.4	88	44	000.0	03.0	06.5	01.8
2005								
01	23.1	08.2	90	47	000.0	03.4	05.3	02.2
02	22.8	05.4	87	36	000.0	03.3	06.5	02.5
03	21.2	05.2	90	45	001.8	03.7	06.7	02.2
04	19.9	06.2	92	46	000.6	03.9	06.3	02.6
05	20.9	06.2	–	–	000.0	03.0	06.1	02.3
06	25.5	09.6	94	45	000.0	03.6	07.8	03.30
07	28.9	11.3	80	35	000.0	04.4	08.4	03.7
08	24.5	06.4	85	34	000.0	04.2	09.6	04.3
09	31.2	12.4	85	33	002.8	03.6	09.4	04.4

Fig.1:Meteorological data during crop season 2003-04

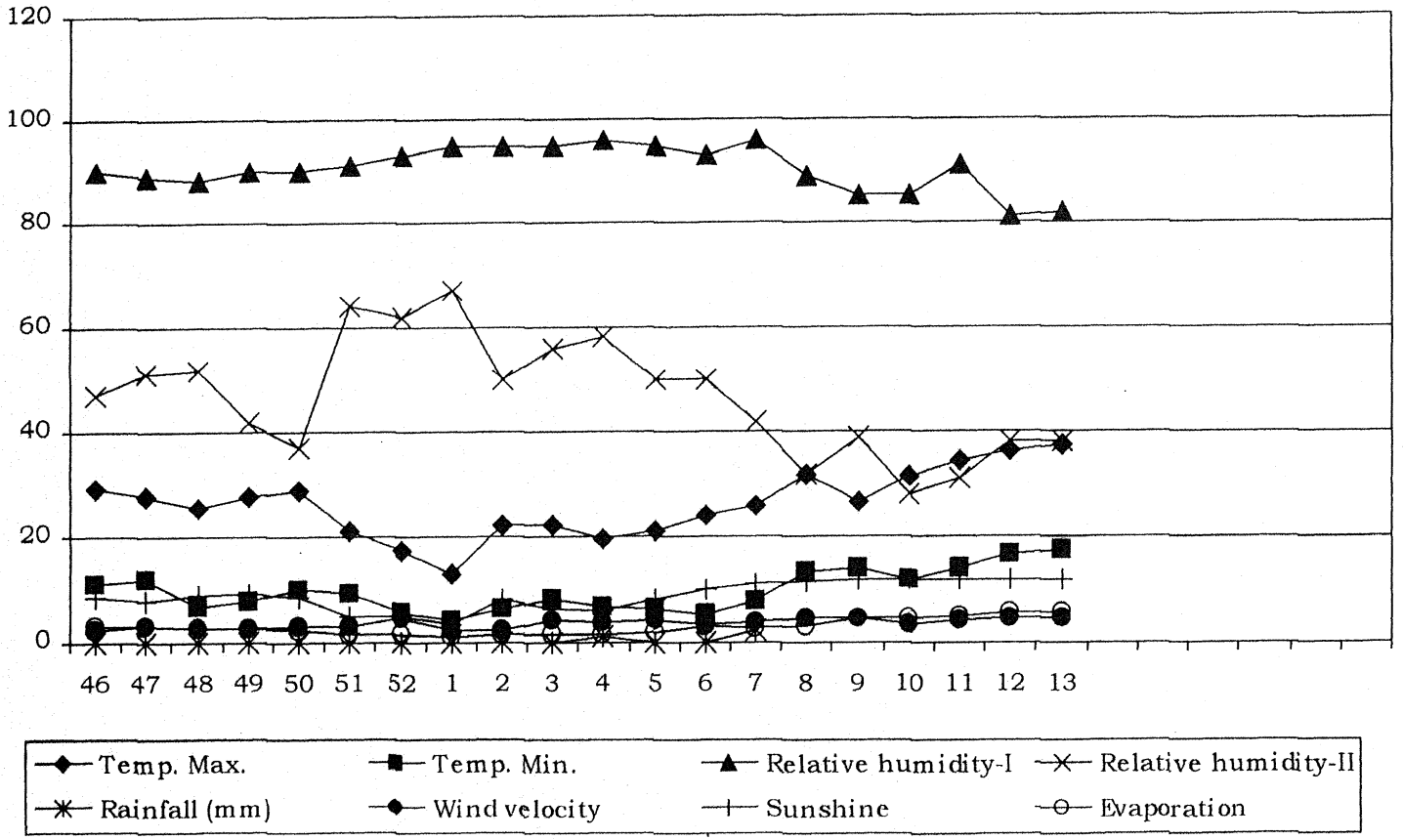
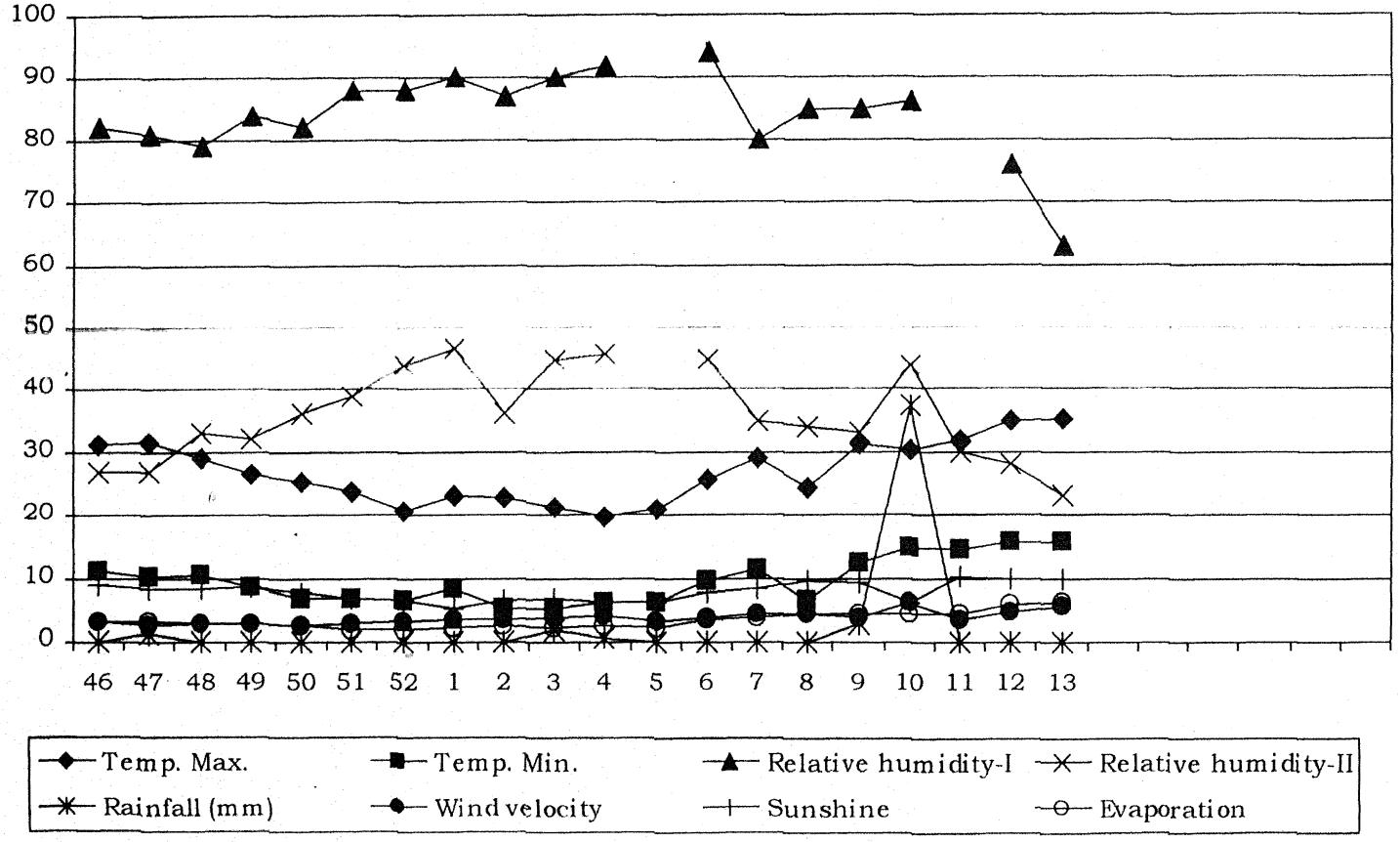


Fig.2:Meteorological data during Rabi crop season 2004-05



10	30.4	14.7	86	44	037.2	06.2	06.1	04.2
11	31.8	14.6	—	30	0000	03.3	10.1	04.3
12	34.9	15.6	76	28	000.0	04.6	10.0	05.8
13	35.3	15.3	63	23	000.0	05.7	10.0	06.2

The weather data given in Table-1 and Table-2 was normal for the mustard in the tract.

CROPPING HISTORY OF THE FIELD:

The cropping history of the experimental field during the past four year is given in table-3.

Table-3: Details of cropping sequences.

Year	Kharif	Rabi	Zaid
2000-2001	Chari	Mustard	-
2001-2002	Soyabean	Wheat	-
2002-2003	Moong	Mustard	
2003-2004	Chari	Present Experiment	
2004-2005	Moong	Present Experiment	

SOIL STATUS:

To know the physio-chemical nature of the soil, a composite soil sample was taken with the help of soil Auger to depth of 20 cm from experimental field before sowing of crop for analysis. This soil sample was subjected to mechanical and chemical analysis. The results as obtained from the soil analysis are presented in table (4a, b, c).

Table-4(a): Mechanical analysis of the soil.

S.N.	Ingredient	Percent value	Method of determination
1.	Coarse sand	28.13	International Pipette method
2.	Silt	50.10	Piper (1950)
3.	Clay	21.77	--do--
4.	Texture	Silty loam	

Table-4(b): Chemical analysis of the soil.

SN	Ingredient	Value		Method of determination
		2003-04	2004-05	
1.	Organic carbon	0.58%	0.54%	Walkley and Blacks rapid titration method (Piper 1950)
2.	Available Nitrogen	0.063%	0.067%	Alkaline permanganate method (Subbiah and Asiza 1956)
3.	Available phosphorus (Kg/ha)	15.65	14.87	Olson's method (Olson et al., 1956)
4.	Available potassium (Kg/ha)	206.5	210.0	Flamephotometer (Jackson 1967)

Table-4(c): Physico-Chemical characteristics.

SN	Ingredient	Value		Method of determination
		2003-04	2004-05	
1.	Cation exchange capacity (C.E.C.)	15.3%	15.2%	Ammonium acetate method (Piper, 1950)
2.	Electrical conductivity (mmhos/cm)	0.34	0.34	Solubridge method (Richard, 1954)
3.	Soil PH	7.8	7.8	Blackmans Glass Electrode PH meter

EXPERIMENTAL DETAILS:

The details of the experiment conducted for the present research work are as given below.

1. LAYOUT:

The details of layout plan is given below and depicted in Fig.3.

1. Experimental design		Split plot design
2. Number of treatments		3x3x3 = 27
3. Number of replications		3
4. Total number of plots		27x3 = 81
5. Plot size	(i) Gross	5.4M x 3.6M = 19.44 Sq.m.
	(ii) Net	4.4M x 2.6M = 11.44 Sq.m.

LAY OUT

Field Border Cum Irrigation Channel

Replication - I				Replication Border cum Irrigation Channel	Replication - II				1.5M	Replication - III				
$D_2G_2V_2$	Sub Irrigation Channel (SIC)	$D_2G_1V_2$	$D_2G_3V_2$		$D_3G_2V_3$	1 M. S I C	$D_3G_1V_2$	$D_3G_2V_1$		$D_1G_3V_2$	S I C	$D_1G_2V_2$	$D_1G_1V_3$	
$D_2G_3V_1$		$D_2G_2V_3$	$D_2G_3V_3$		$D_3G_2V_2$		$D_3G_3V_1$	$D_3G_1V_1$		$D_1G_2V_1$		$D_1G_1V_1$	$D_1G_3V_1$	
$D_2G_1V_1$		$D_2G_2V_1$	$D_2G_1V_3$		$D_3G_3V_2$		$D_3G_1V_3$	$D_3G_3V_3$		$D_1G_2V_3$		$D_1G_3V_3$	$D_1G_1V_2$	
$D_1G_2V_1$		$D_1G_3V_2$	$D_1G_1V_1$		$D_2G_2V_2$		$D_2G_3V_1$	$D_2G_1V_2$		$D_3G_2V_1$		$D_3G_1V_2$	$D_3G_2V_2$	
$D_1G_2V_2$		$D_1G_3V_1$	$D_1G_3V_3$		$D_2G_3V_2$		$D_2G_1V_1$	$D_2G_2V_3$		$D_3G_3V_3$		$D_3G_3V_2$	$D_3G_1V_3$	
$D_1G_3V_3$		$D_1G_1V_2$	$D_1G_1V_3$		$D_1G_3V_3$		$D_2G_3V_3$	$D_2G_2V_1$		$3G_2V_3$		$D_3G_1V_1$	$D_3G_3V_1$	
$D_3G_1V_2$		$D_3G_3V_2$	$D_3G_2V_2$		$D_2G_1V_3$		$D_1G_1V_1$	$D_1G_3V_1$		$D_2G_2V_2$		$D_2G_3V_1$	$D_2G_2V_2$	
$D_3G_2V_1$		$D_3G_1V_1$	$D_3G_3V_3$		$D_1G_2V_1$		$D_1G_1V_2$	$D_1G_2V_2$		$D_2G_2V_3$		$D_2G_1V_1$	$D_2G_3V_3$	
$D_3G_3V_1$		$D_3G_2V_3$	$D_3G_1V_3$		$D_1G_2V_3$		Net Plot size $D_1G_3V_2$	$D_1G_3V_3$		Gross Plot size $D_2G_2V_1$	3.6 M	$D_2G_3V_2$	$D_2G_1V_3$	

Field Border cum Irrigation Channel

der cum main irrigation channel	-	1.5 Meter	Gross plot size	-	5.4x3.6 Meter
on border cum irrigation channel	-	1.5 Meter	Net plot size	-	4.4x2.6 Meter
ation channel	-	1.0 Meter	Total length	-	57.5 Meter

3 M

45

6. Plot border	0.5 M
7. Block border	1.0 M
8. Irrigation channel	1.0 M
9. Field border	1.5 M
10.Total experimental area	2147.0m^2
11. Sown area	1458.0m^2
12. Area under Layout	689.0m^2

2. DETAILS OF TREATMENTS:

The experiment was conducted with the following treatments.

(a) MAIN PLOT TREATMENT-3

1. Sowing dates	Notation
(1) 10 Oct.	D_1
(2) 25 Oct.	D_2
(3) 10 Nov.	D_3

(b) SUB PLOT TREATMENT (3x3)

1. Planting geometry

(1) 30x15 cm	G_1
(2) 45x15 cm	G_2
(3) 60x15 cm	G_3

(c) VARIETIES - 3

1. Varuna	V_1
2. Pusa bold	V_2
3. Jagannath	V_3

(d) TOTAL TREATMENT COMBINATIONS – 27

PRESOWING OPERATIONS:

(1) PREPARATORY TILLAGE OPERATIONS:

The first ploughing was done by mould board plough followed by levelling by wooden planker. Thereafter, two ploughings were done by cultivator and one ploughing by country plough followed by planking. Timely primary tillage practices were given properly to make the soil firm friable for ensuring proper germination of seeds.

2. LAYOUT:

As per plan, the layout was done 9.10.2003 in 2003-04 and 9.10.2004 in 2004-05 and sowing was done as per the treatments.

3. SEED RATE AND SOWING:

Properly graded seeds of varieties Varuna, Pusa bold and Jagannath was sown @ 7Kg/ha. The sowing was done according to treatment at 30,45 and 60cm raw spacings and the depth of the seeds was kept 2.5cm in the soil. After sowing the seeds, channels for irrigation were make manually as per the layout given in Fig.3.

4. FERTILIZERS APPLICATION -

Uniform doses of 80Kg N, 40 Kg P_2O_5, and 30 Kg K_2O/ha. are applied through Urea, D.A.P. and Muriate of potash fertilizers. The half dose of Nitrogen and full dose of phosphorus and potassium were applied in the field at the sowing time. The remaining half dose of Nitrogen was given after 1st irrigation as top dressing i.e. 35 days age of crop.

POST SOWING OPERATIONS:

1. INTERCULTURE:

The weeds were removed from the entire experimental plot through hand weeding with the help of "Khurpi" after 30 days sowing crop in each years.

2. THINNING:

The thinning in the crop field was done 30 days after sowing to maintain plant to plant space at 15 cm.

3. IRRIGATION:

In each year, the crop was irrigated at 30 days and 75 days after sowing to reduce the moisture stress in the crop.

4. PLANT PROTETCION:

Two spraying of 0.03 percent Rogar insecticide solution was sprayed 60 days and 90 days after sowing the crop in each year to control mustard saw fly and mustard aphid insects.

5. HARVESTING:

First the one border row from both sides length wise were harvested on 30.3.2004 in first year and 24.3.2005 in the second year of the trail. The harvesting of net plot was done 2.4.2004 and 28.3.2005. The harvested crop was left in field for four days for sun drying and after this, the net plot production was transported plot wise to the threshing floor.

6. THRESHING:

Before threshing, each bundle/plot was weighted for recording total produce and then threshing was done. The grain was recorded in kilograms with the help of pan balance. The

differences between the total weight of produce of each plot and grain weight showed the weight of stover.

BIOMETRICAL OBSERVATION

Particular of the observations regarding periodic growth, yield attributing characters and yield are given in table-5.

Table-5: Showing the Biometrical observations.

SN	Observations	Frequency	Sample size
(A) PRE HARVEST STUDIES:			
1.	Number of plants/plot (10.40Sq.m.)	At 30 days and at harvest	The total number of plants per plot were counted after thinning
2.	Height of main shoot (cm)	At 30,60 and 90 days after sowing and at harvest	Three plants, from each net plot were randomly tagged and height was measured from ground level to tap of main apix.
3.	Number of functional leaves/plant	At 30,60 and 90 days age of crop	Observation were taken from three tagged plants/plot.
4.	Leaf area (cm)	--do--	--do--
5.	Fresh weight/ plant (gm)	At 30.60 and 90days after sowing and at harvest	Three plants from each plot corner were uprooted and cut from root system and weighed.
6.	Dry weight/ plant(gm)	--do--	--do--
7.	Number of primary, secondary and tertiary branches/ plant	After harvest the crop	Observations recorded from tagged plants.

8.	Days to 50% flowering	--	Observation were taken at 50% flowering per plot.
9.	Days to 50% maturity	--	Observation were recorded 50% maturity per plot.
(B) POST HARVEST STUDIES:			
1.	Number of siliquae/plant	At harvesting	From three tagged plants from each plot
2.	Weight of siliquae/plant	"	--Do--
3.	Length of siliqua (cm)	"	Five siliquae form tagged plants/ plot
4.	Weight of siliquae (mg)	"	Five siliquae from tagged plants/ plot
5.	Number of seeds/siliqua	"	"
6.	Weight of seeds /siliqua	"	"
7.	Weight of seeds/plant(g)	"	Three tagged plants/plot
8.	Total produce (q/ha)	"	From Net plot area basis
9.	Seed yield(q/ha)	"	"
10.	Stover yield (q/ha)	"	"
11.	Harvest index	--	Grain yield (q/ha) ----------x 100 Total Produced (q/ha)

(C) POST HARVEST STUDIES:

(1) SOIL STUDIES:

Initial composite soil sample was collected from the experimental field for analysis of different soil constitutes viz.

textural class, PH, Electrical conductivity, organic carbon, percent and available nitrogen phosphorus and potassium.

QUALITY STUDIES:

(1) 1000SEEDS WEIGHT (g):

Seed sample was taken from net plot.

(2) PROTEIN CONTENT OF SEEDS:

Total nitrogen content was estimated by Kjeldahls flask method (Chapman and Pratt, (1961) Then crude protein in seeds was calculated by multiplying nitrogen/percent with the factor 6.2 as given below.

$$0.0014 \times 100 \times 10 \times A = N$$

Where; A = 10 burette reading

Percent protein = Percent of Nitrogen x 6.25

(3) PERCENT OF OIL CONTENT:

To determine the quality of mustard grain estimation of oil content in percent was estimated by 50 x hlect's oil extraction method.

(D) ECONOMIC STUDIES:

Total cost of cultivation (Rs/ha), Gross income (Rs/ha) Net income (Rs/ha) and Benefit/Cost ratio were calculated according to the prevailing cost of input and market price of the seed.

STATISTICAL ANALYSIS:

The data collected on various characters were analysed separately according to analysis of various technique for judging the effect of different treatments on plant growth characters yield

and quality of mustard crop. Critical difference was calculated only for those characters which were found significant at 1% or 5% level of significance (Fisher, 1957) The skeleton of analysis of variance of the design is presented in table-6.

Table-6: Skelton of analysis of variance.

Sources of variation	D.F.	S.S.	M.S.S.	'F' calculated	'F' value	
					5%	1%
1. Replication	2				-	-
2. Sowing dates (D)	2				6.94	18.0
3. Error (a)	4				-	-
4. Planting geometry(G)	2				3.20	5.10
5. Varieties (V)	2				3.17	5.10
6. D x G	4				2.57	3.76
7. D x V	4				2.57	3.76
8. G x V	4				2.57	3.76
9. D x G x V	8				2.15	2.92
10. Error (b)	48				-	-
Total	80					

Calculation of SEM ± and C.D.

(1) For sowing dates –

(i) $SEM \pm \sqrt{\frac{VE(a)}{27}}$ $\quad SEM\ d \pm \sqrt{\frac{2VE(a)}{r \times v \times g}}$

(ii) C.D. at 5% = SEM ± $\sqrt{2}$ x t value at 5%

(iii) C.V. % = $\frac{\sqrt{\text{M.S.S. of Er.(a)}}}{\text{General mean}} \times 100$

(2) For Planting Geometry

(i) SEM ± = $\frac{\sqrt{2VE\ (b)}}{27}$

(ii) C.D. at 5% = SEM ± $\sqrt{2 \times t \text{ value at } 5\%}$

(3) For Varieties

(i) SEM± = $\frac{\sqrt{2\ EV(b)}}{27}$

CD = SEM ± x $t_{5\%}$

(ii) C.D. at 5% = SEM± $\sqrt{2 \times t \text{ value at } 5\%}$

(4) For D x G, D x V and G x V

(i) SEM ± $\frac{\sqrt{2VE}}{9}$

(ii) C.D. for above combinations = SEM ± $\sqrt{2 \times t \text{ at } 5\% \text{ value D.F.}}$

(5) For D x G x V

(i) SEM ± $\frac{\sqrt{EV}}{3}$

(ii) C.D. at 5% = SEM ± $\sqrt{2 \times t \text{ 5\% value D.F.}}$

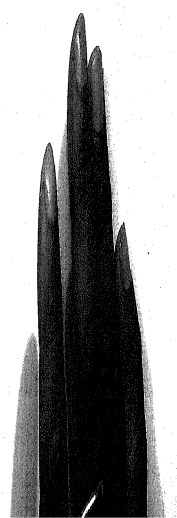
(6) C.V. % for sub plot treatments.

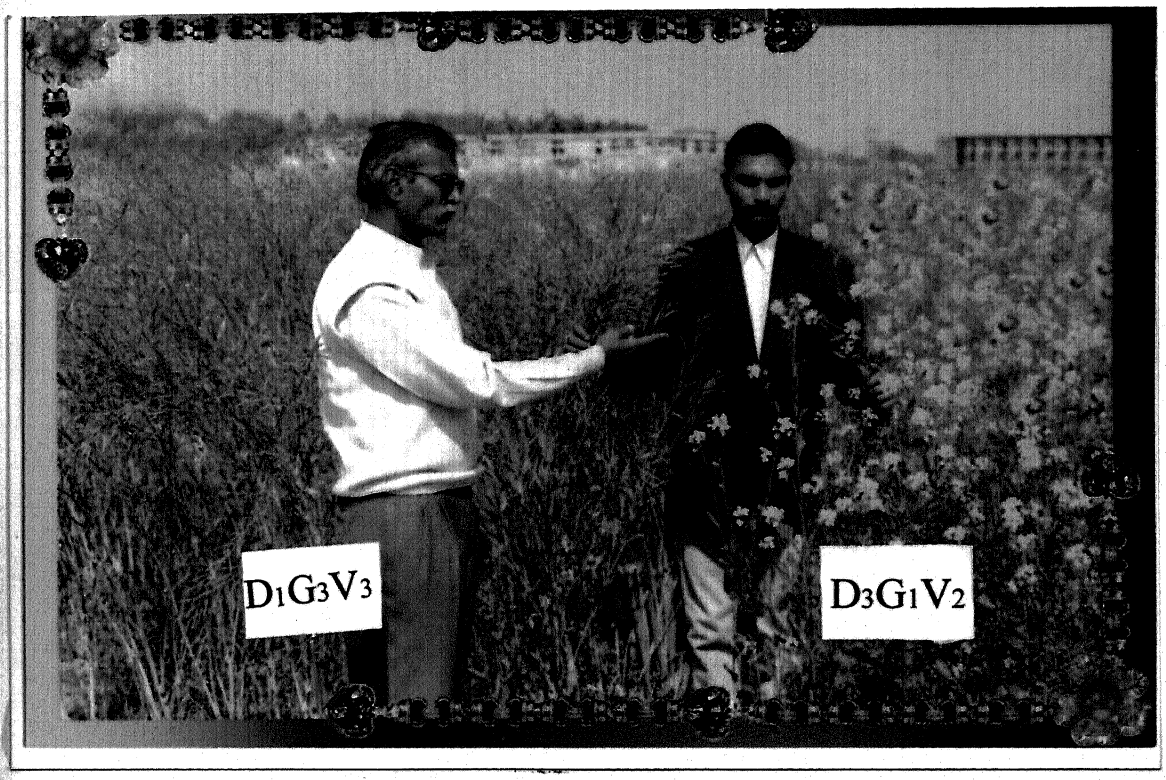
$\frac{\sqrt{\text{M.S.S. for Error (b)}}}{\text{General mean}} \times 100$

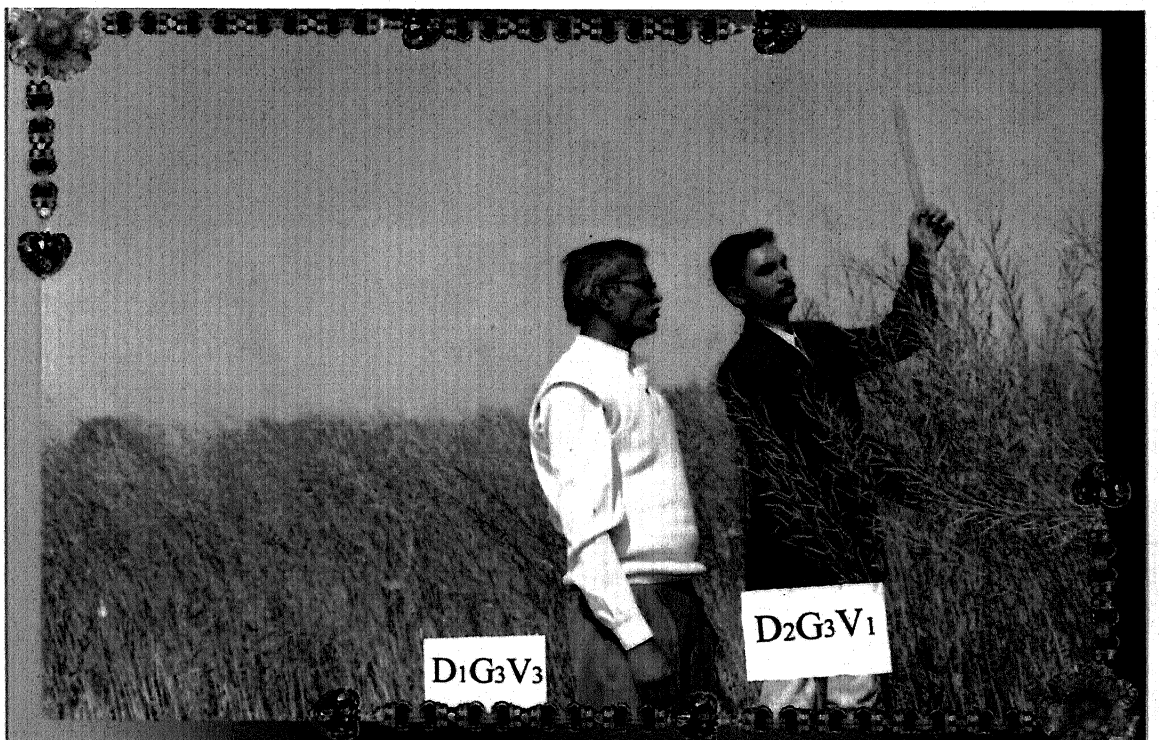
General Mean (G.M.) = $\frac{\text{Grand Total}}{\text{Total No. of plots}}$

PRESENTATION OF DATA:

The data of various growth, yield and quality characters were studied, summarized and presented in different tables.




D1G3V3
D3G1V2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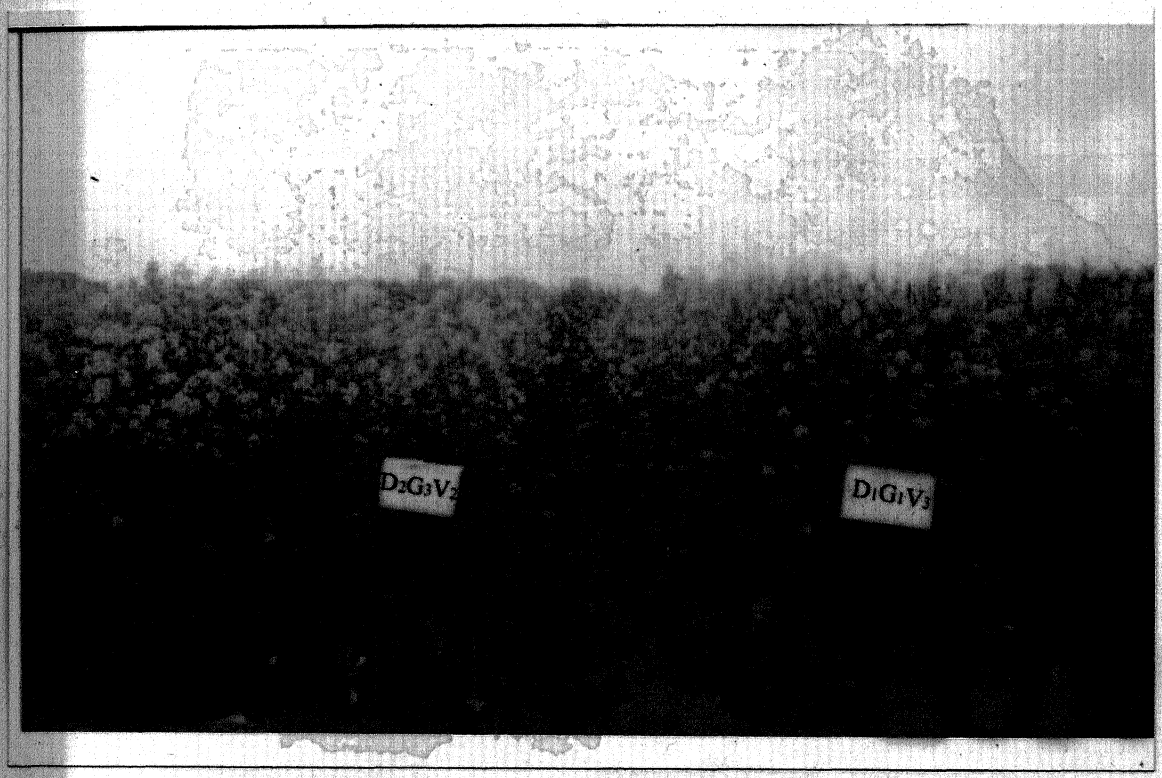
D2G3V1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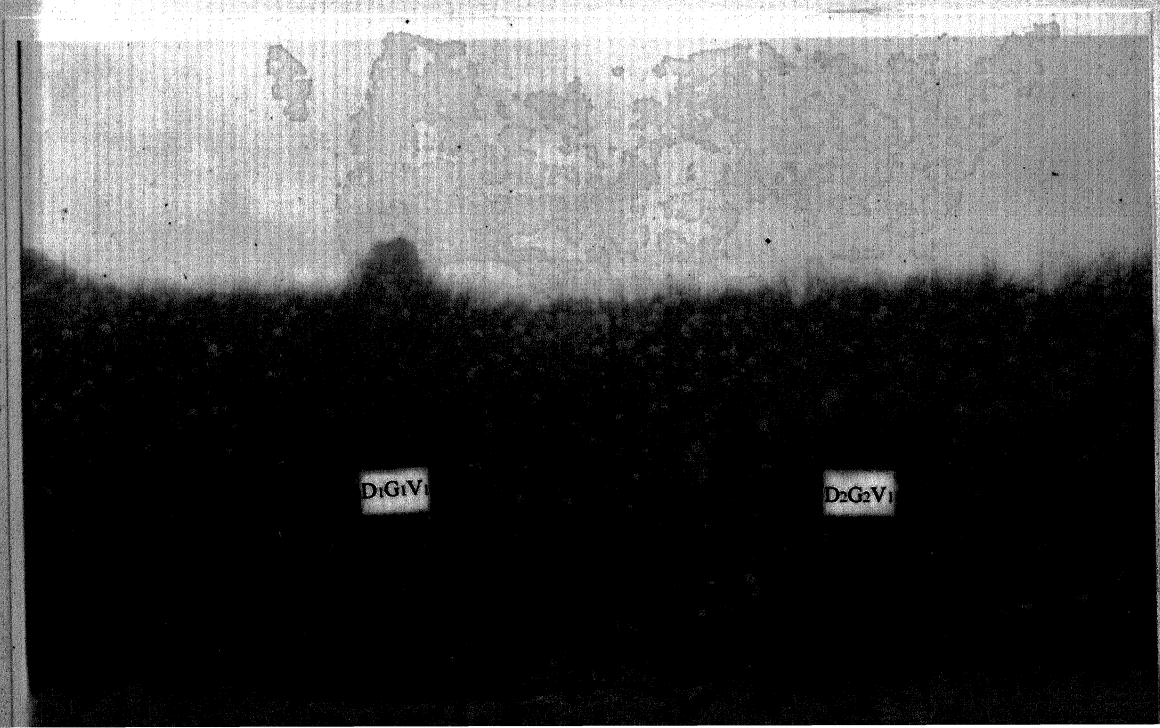
$D_1G_1V_3$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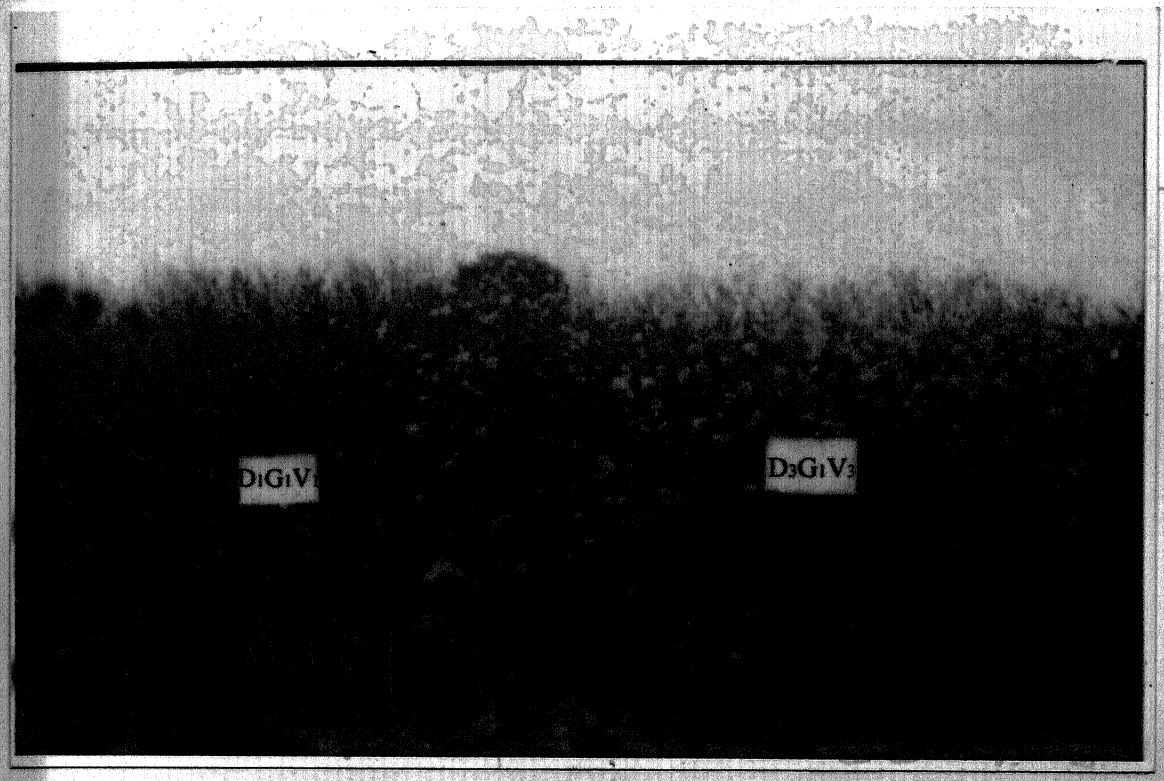
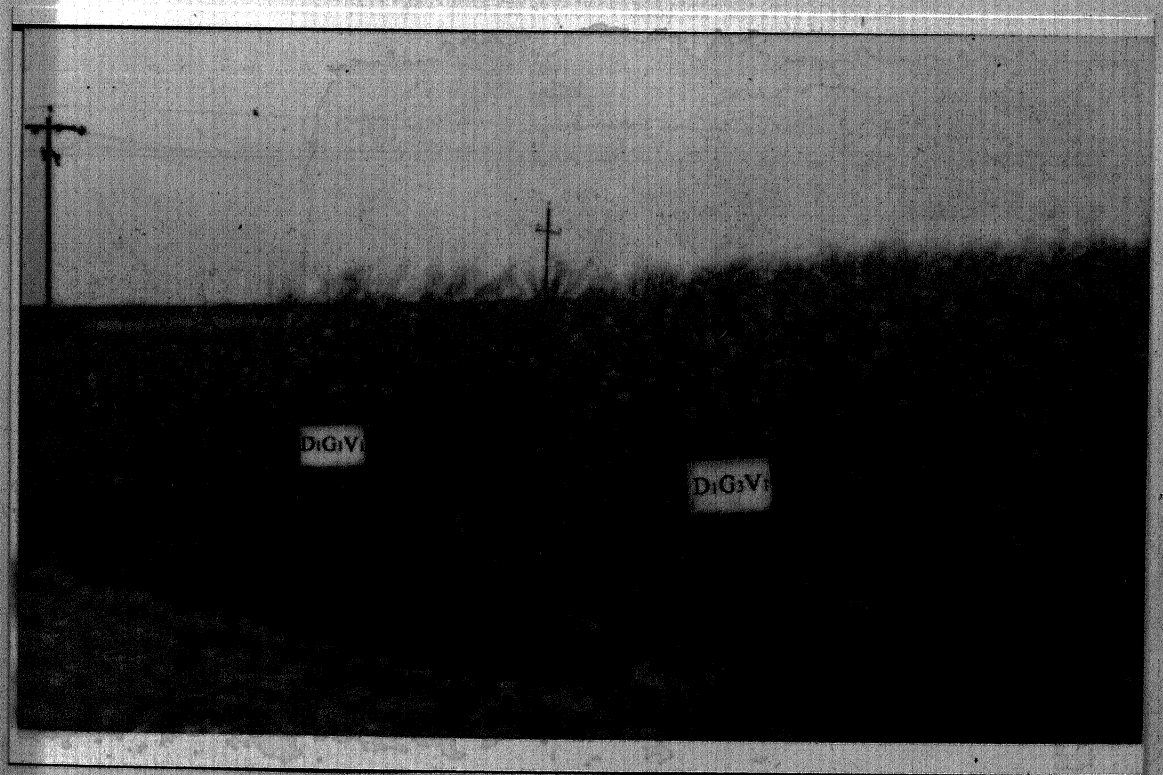
$D_2G_2V_1$


D1G1V1
D3G1V3


D1G1V1
D1G3V1

Chapter - IV
EXPERIMENTAL FINDINGS

CHAPTER - IV

EXPERIMENTAL FINDINGS

The present field investigation entitled "Effect of sowing dates, Planting geometry and varieties on growth, yield and quality of Mustard (Brassica juncea Coss) under irrigated condition" was carried out for two presented years during Rabi season 2003-2004 and 2004-2005 with the main objective was to find out the suitable date of sowing, planting geometry and variety. For this purpose, three dates of sowing (10 Oct., 25 Oct and 10 Nov.) were tried with three planting geometries (30x15cm, 45x15 cm and 60x15 cm) and three mustard varieties (Varuna, Pusa bold and Jagannath) in a three replicated split plot design are presented in this chapter under the appropriate heads.

All the growth characters, yield attributing characters, yield and quality were statistically analysed separately in both the years and the results are summarized in different tables. In order to understand, the effect of treatments, the data have also been given in appendix tables for reference.

PLANT STAND:

It was recorded initially after thinning to maintain plant geometry and finally at maturity of crop. The data for both are summarized and presented in table (7), fig. (4) and statistically analysed data have been given in appendix (I).

Table – 7 : Number of plants/unit area as influenced by different treatments.

Treatments	Initial plant population			Final plant population		
	2003-04	2004-05	Mean	2003-04	2004-05	mean
Date of sowing						
D_1 (10 Oct.)	288.55	287.92	288.23	285.33	285.29	285.31
D_2 (25 Oct.)	288.59	288.33	288.46	285.33	285.49	285.41
D_3 (10 Nov.)	288.37	288.07	288.22	285.33	285.22	285.27
SE ±	3.45	3.65		34.49	4.44	
C.D. at 5%	N.S.	N.S.		N.S.	N.S.	
Planting geometry (Cm)						
G_1 (30x15 Cm)	399.18	398.46	398.82	395.10	395.59	395.49
G_2 (45x15 Cm)	266.70	287.40	277.05	264.59	285.03	274.81
G_3 (60x15 Cm)	199.62	198.44	199.03	198.00	195.37	196.68
SE ±	4.63	5.69		5.259	6.12	
C.D. at 5%	9.71	11.45		10.57	12.31	
Varieties						
V_1 (Varuna)	287.85	287.37	287.61	284.34	284.44	284.39
V_2 (Pusa bold)	289.11	288.96	288.24	286.29	286.25	286.27
V_3 (Jagannath)	288.55	288.00	288.27	285.33	285.29	285.31
SE ±	4.63	5.69		5.259	6.12	
C.D. at 5%	N.S.	N.S.		N.S.	N.S.	
C.V. (%)	6.149	7.26		6.77	7.88	

N.S. = Non Significant.

Fig.4: Initial Plant Population as influenced by different treatments.

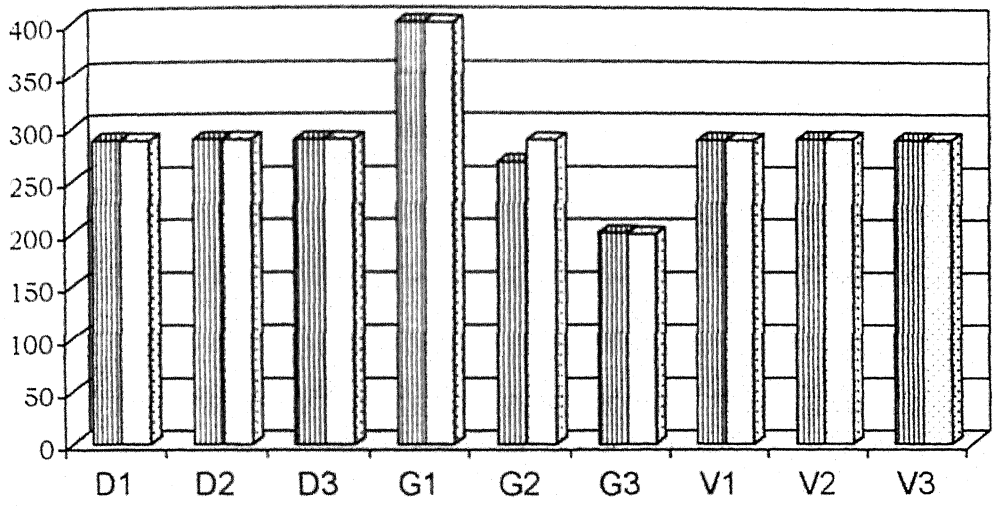
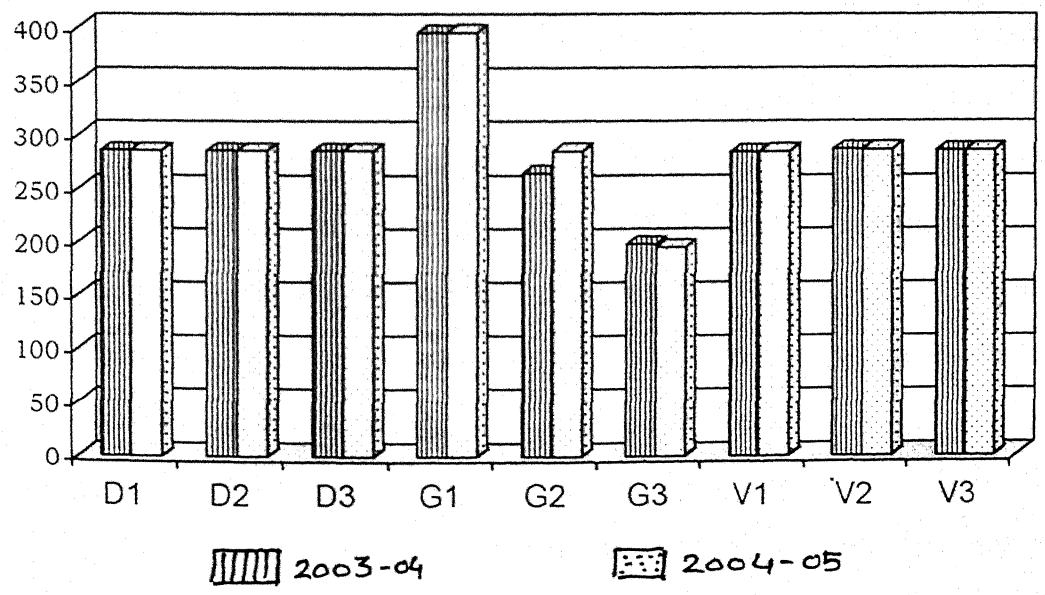


Fig.4: Final Plant population as influenced by different treatments.



The data given in table (7) indicate that plant stand was influenced non significantly by dates of sowing and varieties during both years.

EFFECT OF PLANTING GEOMETRIES:

It is evident from table (7) that different planting geometries were significantly differed among each other in maintaining plants/unit area in both the years and was recorded higher in G_1 (30x15cm) planting geometry. In mean value basis, G_1 (30x15cm) planting geometry maintained final plant stand of 395.49 plants/unit area which was 30.53 and 50.09 percent higher than G_2 (45x15cm) and G_3 (60x15cm) planting geometries, respectively.

GROWTH PHENOLOGY:

The growth of the crops was studied in terms of height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant were recorded at successive stages of crop growth i.e. 30, 60, 90 days after sowing and at harvest in both the years of observations. The number of primary, secondary and tertiary branches/plant were recorded at 90 days age of crop. The days to 50% flowering and days to 50% maturity date were also recorded for growth study.

HEIGHT OF MAIN SHOOT (cm):

The data on height of main shoot (cm) are summarized and presented in table (8) depicted in fig.(5) and statistically analysed data are given in appendix (II).

Reference to table (8) and fig.(5) showed that height of main shoot (cm) was increased abruptly in both the years up to 90 days age of crop. After that, the increasing rate was quite show up to harvest.

EFFECT OF SOWING DATES:

The presented data indicated that different sowing dates were significantly differed in increasing height of main shoot (cm) in different days of observations and at harvest in both the years. The sowing date D_2 (25 Oct.) increased maximum value followed by D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates respectively.

EFFECT OF PLANTING GEOMETRIES:

Table (8) showed that increased planting space was also increased height of main shoot (cm) at all the observations of growth in both the years. The G_3 (60x15 cm) planting geometry increased significantly more value over G_2 (45x15 cm) and G_1 (30x15 cm) in both the years. The value in order to G_3, G_2 and G_1, respectively

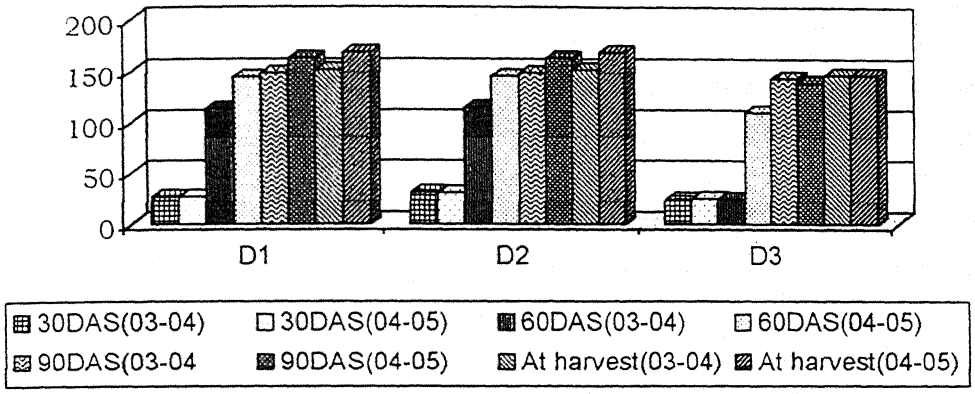
PERFORMANCE OF VARIETIES:

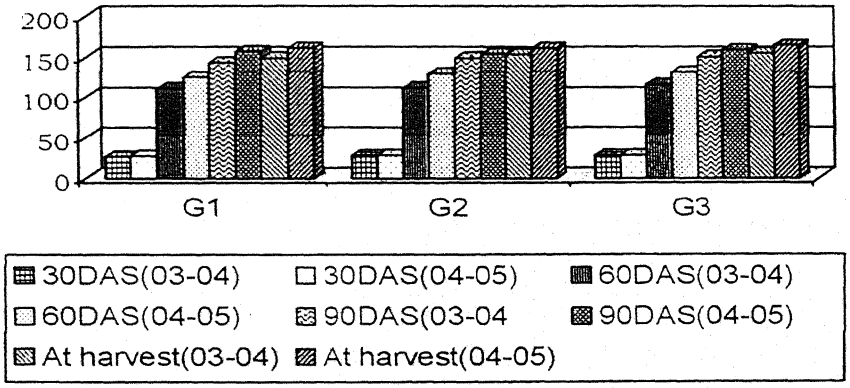
The data showed that variety V_2 (Pusa bold) increased more height of main shoot (cm) over other varieties in both the years at all the observations of growth. The variety V_2 (Pusa bold) was significantly superior to variety V_1 (Varuna) in this respect and V_3 (Jagannath) in 60 days observation also. The variety V_1 also had significantly lowest value over V_3 variety in this regard.

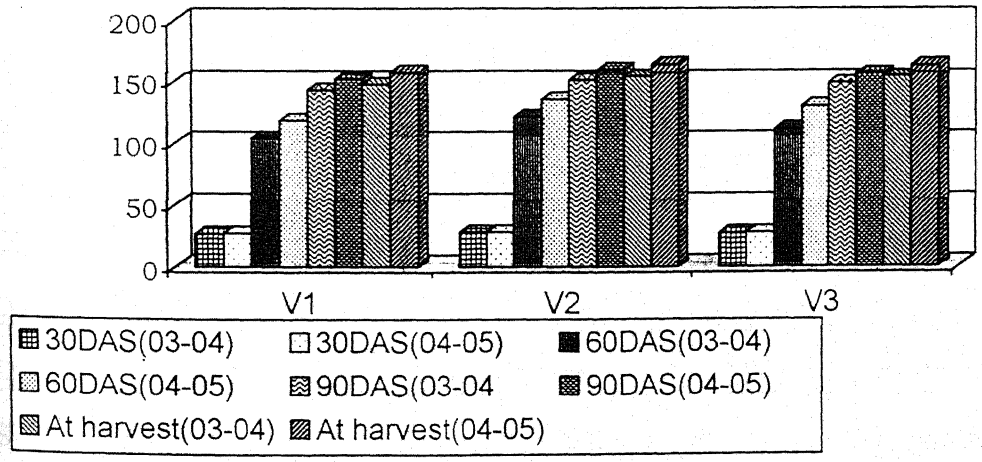
Table - 8 : Height of plant (cm) as influenced by different treatments.

Treatments	Height of plant											
	30			60			90			At harvest		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
Date of sowing												
D_1 (10 Oct.)	27.21	27.45	27.33	113.68	144.69	129.18	148.47	162.45	155.46	151.48	168.35	159.91
D_2 (25 Oct.)	31.38	31.20	31.29	114.98	145.09	130.09	151.66	169.19	157.05	156.60	173.03	164.81
D_3 (10 Nov.)	24.78	25.05	24.91	109.54	95.30	102.42	143.06	139.07	141.06	146.39	146.39	146.39
SE ±	0.69	0.14	-	0.47	0.40	-	0.81	1.56	-	0.99	0.81	
C.D. at 5%	1.90	0.40	-	1.30	1.11	-	2.26	4.33	-	2.75	2.25	
Planting geometry (Cm)												
G_1(30x15Cm)	26.76	27.19	26.98	110.77	124.41	117.59	143.75	157.30	150.52	148.77	161.31	155.04
G_2(45x15Cm)	27.98	28.14	28.06	111.44	129.31	120.37	148.82	153.69	151.25	153.42	161.58	157.50
G_3(60x15Cm)	28.26	28.38	28.50	115.99	131.36	123.67	150.62	158.72	154.67	154.84	164.88	159.86
SE ±	0.36	0.37	-	1.29	1.13	-	1.14	2.37	-	0.86	1.33	-
C.D. at 5%	0.72	0.75	-	2.58	2.26	-	2.30	4.76	-	1.72	2.68	
Varieties												
V_1 (Varuna)	27.30	27.36	27.33	104.48	118.98	111.73	143.10	152.06	147.58	147.81	158.81	153.31
V_2(Pusa bold)	28.37	28.47	28.42	121.92	135.71	128.82	151.33	160.50	155.91	154.63	164.95	159.79
V_3(Jagannath)	27.69	27.87	27.78	111.80	130.38	121.09	148.75	157.15	152.95	154.58	164.02	159.30
SE ±	0.36	0.37		1.29	1.13		1.14	2.37		0.86	1.33	
C.D. at 5%	0.72	0.75		2.58	2.26		2.30	4.76		1.72	2.68	
C.V. (%)	4.75	4.89		4.19	3.22		2.84	5.58		2.07	3.01	

Fig.5 : Height of plant (cm) as influenced by different treatments.







SIGNIFICANT INTERACTIONS:

The interaction effect in respect to height of main shoot (cm) under different days of observations in dates of sowing planting geometries and varieties are given as follows.

Table-8(a): Height of main shoot (cm) at 60 days as affected by interaction, sowing dates and varieties (DxV) 2004-05.

D x V	V_1	V_2	V_3
D_1	130.09	155.07	150.09
D_2	137.88	151.76	144.40
D_3	86.96	100.29	96.63
SE ± 1.64	C.D. at 5% 3.37		

It is revealed in table (8a) that interaction D_2V_1 increased more height of main shoot (cm) which was at par with D_2V_2 and significant over D_1V_3, D_2V_3, D_2V_1 etc. respectively. The significantly lowest values were recorded in D_1V_1 interactions.

Table-8(b): Height of mainshoot (cm) as affected by interactions DxG and DxV at harvest in 2004-2005.

D/G	G_1	G_2	G_3	D/V	V_1	V_2	V_3
D_1	166.41	173.16	165.48	D_1	165.83	174.50	164.72
D_2	170.48	176.28	173.32	D_2	171.84	179.47	167.76
D_3	147.03	145.20	146.94	D_3	157.16	138.08	143.91
SE ± 2.05		C.D. at 5% 4.36		SE ± 2.05		C.D. at 5% 4.36	

It is showed in table (8b) that interaction D_2G_2 increased more length of main shoot (cm) which was at par with D_2G_3 and D_1G_2 and significant over D_2G_1, D_1G_1, D_1G_3 etc, respectively.

Table (8b) indicated that height of main shoot (cm) was significantly increased in D_2V_2 interaction over D_1V_2, D_2V_1, D_2V_3, etc. interactions, respectively

Table-8(c): Height of main shoot(cm) as affected by interaction GxV at harvest in 2004-2005.

G x V	V_1	V_2	V_3
G_1	163.16	158.40	156.60
G_2	163.84	164.30	137.47
G_3	167.82	169.34	162.34
SE ± 2.30	C.D. at 5% 4.63		

Table presented (8c) revealed that G_3V_2 interaction increased maximum height of main shoot (cm) which was at par with G_3V_1 and significant over G_2V_2, G_2V_1, G_1V_1, G_3V_3 etc, respectively.

Table-8(d): Height of main shoot (cm) at harvest as influenced by interaction DxGxV in 2004-2005.

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	166.96	175.36	169.14	176.01	183.61	169.23	172.55	179.44	164.97
D_2	164.69	161.97	172.57	168.05	191.29	160.15	164.75	170.25	161.45
D_3	157.85	137.90	145.32	159.43	133.14	143.04	154.22	143.22	143.40
SE ± 3.99				C.D. at 5% 8.03					

Reference to table (8d) showed that height of main shoot (cm) was increased more in interaction $D_2G_2V_2$ which was at par with $D_1G_2V_2$ and significantly superior over $D_1G_3V_2$, $D_1G_2V_1$, $D_1G_1V_2$, $D_2G_1V_3$ etc. respectively. The lowest value was recorded in $D_3G_2V_2$ interactions.

NUMBER OF FUNCTIONAL LEAVES PER PLANT:

The data as number of functional leaves/plant are summarized and presented in table (9), illustrated in fig. (6) and statistically analysed data are given in appendix (III).

Reference to table (9) showed that number of leaves per plant was increased abruptly up to 60 days stage of crop. After 60 days, it decreased up to 90 days and complete defoliation was observed up to harvest.

EFFECT OF SOWING DATES:

The presented data indicated that more number of functional leaves per plant was recorded in D_2 (25 Oct) sowing date in all the stages of observations in both the years. The D_2 sowing date was significantly superior at 30 and 60 days observation over others dates of sowing but at 60 days, it was at par with D_1 (10 Oct.) in 2004-05 and non significantly affected in 2003-04 in this regard.

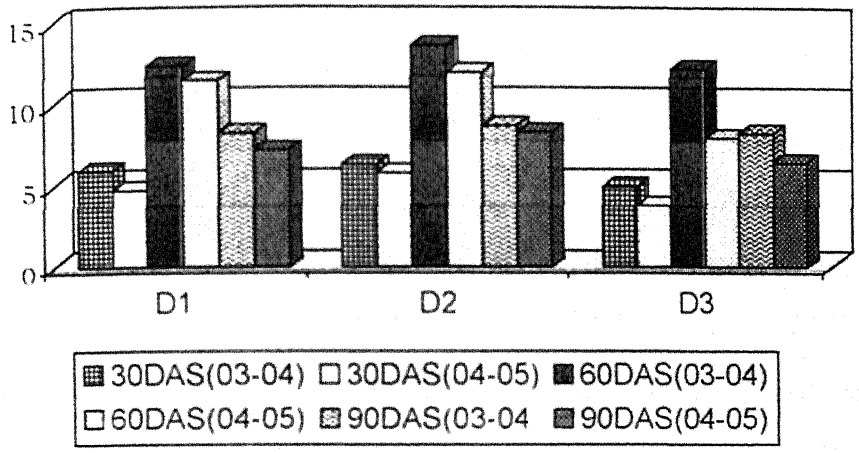
EFFECT OF PLANTING GEOMETRIES:

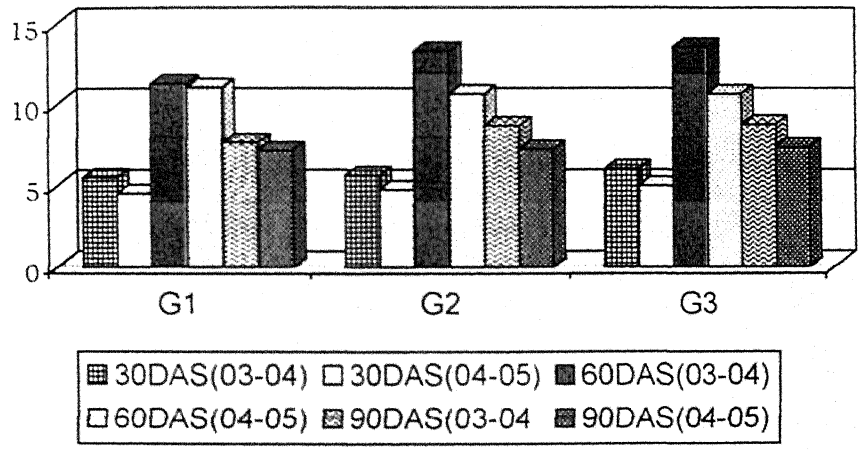
The data showed that planting geometry i.e. G_3 (60x15 cm) increased more number of functional leaves/plant in both the years at all the stages of observations. In early stages, it was significantly but at later stages it was marginally affected over

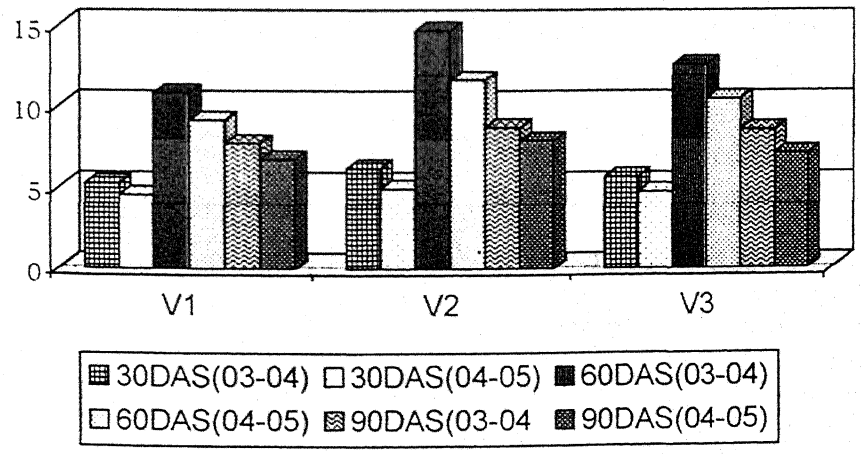
Table - 9 : Functional leaves/plant as influenced by different treatments.

Treatments	Days after sowing								
	30			60			90		
Dates after sowing	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
D_1 (10 Oct.)	5.93	4.73	5.33	12.36	11.43	11.90	8.20	7.15	7.68
D_2 (25 Oct.)	6.27	5.77	6.02	13.58	11.94	12.76	8.65	8.24	8.45
D_3 (10 Nov.)	4.94	3.77	4.36	12.20	7.94	10.07	8.22	6.37	7.30
SE ±	0.30	0.02		0.15	0.23		0.22	0.20	
C.D. at 5%	0.82	0.06		0.43	0.65		N.S.	0.56	
Planting geometry (Cm)									
G_1 (30x15Cm)	5.50	4.54	5.02	11.26	11.04	10.65	7.652	7.15	7.39
G_2 (45x15Cm)	5.62	4.75	5.19	13.32	10.64	11.98	8.69	7.24	7.97
G_3 (60x15Cm)	6.02	4.99	5.51	13.57	10.64	12.11	8.76	7.35	8.06
SE ±	0.20	0.09		0.31	0.25		0.27	0.23	
C.D. at 5%	0.40	0.18		0.62	0.50		0.55	N.S.	
Varieties									
V_1 (Varuna)	5.26	4.56	4.91	10.82	9.18	10.00	7.74	6.74	7.24
V_2 (Pusa bold)	6.23	4.95	5.59	14.71	11.67	13.19	8.74	7.90	8.32
V_3 (Jagannath)	5.66	4.77	5.22	12.61	10.48	11.55	8.59	7.12	7.86
SE ±	0.20	0.09		0.31	0.25		0.27	0.23	
C.D. at 5%	0.40	0.18		0.62	0.50		0.55	0.46	
C.V. (%)	12.82	6.74		8.85	8.81		11.9811.46		

Fig.6 : Functional Leaves/plant as influenced by different treatments.







other planting geometries. The value in order to G_3 (60x15 cm), G_2 (45x15cm) and G_1 (30x15cm), respectively.

PERFORMANCE OF VARIETIES:

The variety V_2 (Pusa bold) produced maximum number of functional leaves/plant at all the stages of observation over other varieties in both the years. The respective variety V_2 was significantly superior in increasing values at all the stages over V_1 (Varuna) variety in both the years.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations on number of functional leaves/plant as follows.

Table-9(a): Number of functional leaves/plant at 60 days as affected by interaction DxG.

DxG	2003-04			2004-05		
	G_1	G_2	G_3	G_1	G_2	G_3
D_1	10.24	13.39	13.44	11.85	11.63	10.80
D_2	11.88	14.94	13.91	11.55	11.63	12.65
D_3	10.64	11.65	13.30	7.42	8.64	7.75
	SE ± 0.45 CD at 5% 0.96			SE± 0.42 CD at 5% 0.95		

It is showed in table (9a) that number of functional leaves/plant was significantly more in D_2G_2 in 2003-04 followed by D_2G_3, D_1G_3, D_1G_2, D_3G_3 etc. While in 2004-05 the more value was recorded in D_2G_3 which was at par with D_1G_1 and significant over D_1G_2, D_2G_2, D_1G_3 etc, respectively.

Table-9(b):Number of functional leaves/plant at 60 days as affected by interaction DxV.

DxV	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
D_1	10.16	15.21	11.70	9.41	12.68	11.84
D_2	11.49	15.25	13.99	10.92	13.02	12.22
D_3	10.79	13.68	12.12	7.18	9.29	7.35
	SE ± 0.45 CD at 5% 0.96			SE± 0.42 CD at 5% 0.95		

Reference to table (9b) indicated that in 2003-04 year the D_2V_2 interaction increased maximum number of functional leaves/plant which was at par with D_1V_2 and significant over other interactions. In 2004-05 year the D_2V_2 interaction was at par with D_1V_2 and D_2V_3 and significant over other interactions in this regard.

Table-9(c): Number of functional leaves/plant at 60 days as affected by interaction GxV.

GxV	2003-04			1004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
G_1	9.76	12.66	11.33	9.62	11.24	11.06
G_2	10.48	16.35	13.11	9.13	12.75	10.02
G_3	12.20	15.12	13.37	8.76	11.01	10.33
	SE ± 0.53 CD at 5% 1.06			SE± 0.43 CD at 5% 0.87		

Table 9(c) found that significantly more number of functional leaves/plant was recorded in G_2V_2 interaction followed by G_3V_2, G_3V_3, G_2V_3 etc respectively in 2003-04 year.

In 2004-05 year the interaction G_2V_2 was also significantly more over G_1V_2, G_1V_3, G_3V_2, G_3V_3 etc interactions, respectively

Table-9(d): Number of functional leaves/plant at 60 days as affected by interaction DxGxV.

2003-2004.

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	10.12	13.27	12.24	11.98	17.96	15.80	12.56	13.32	13.95
D_2	9.56	11.46	9.72	9.43	18.76	11.97	11.51	15.41	13.41
D_3	3.61	13.25	12.25	10.23	13.15	11.57	12.54	14.63	12.75
SE ± 0.91					C.D. at 5% 1.84				

2004-2005

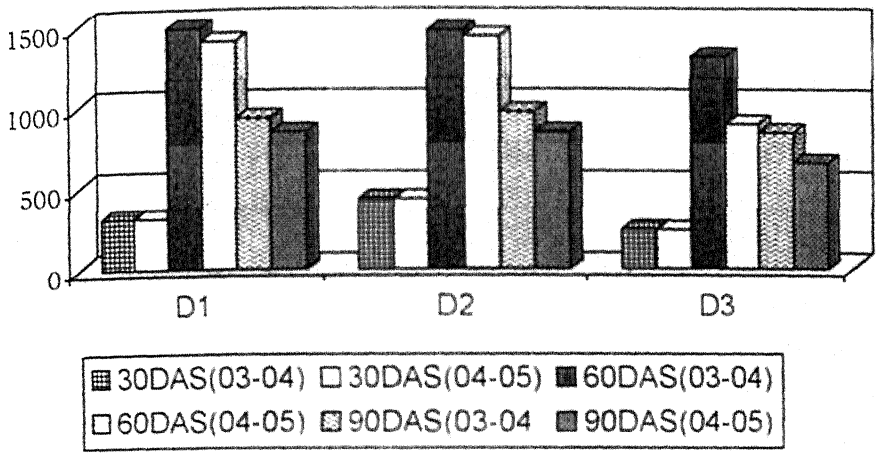
DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	11.18	13.30	13.46	10.60	12.53	11.76	10.98	12.22	11.43
D_2	10.73	12.23	12.58	8.81	14.33	11.76	8.70	12.51	11.19
D_3	6.94	8.19	7.15	7.23	11.40	6.55	6.62	8.29	8.36
SE ± 0.75					C.D. at 5% 1.31				

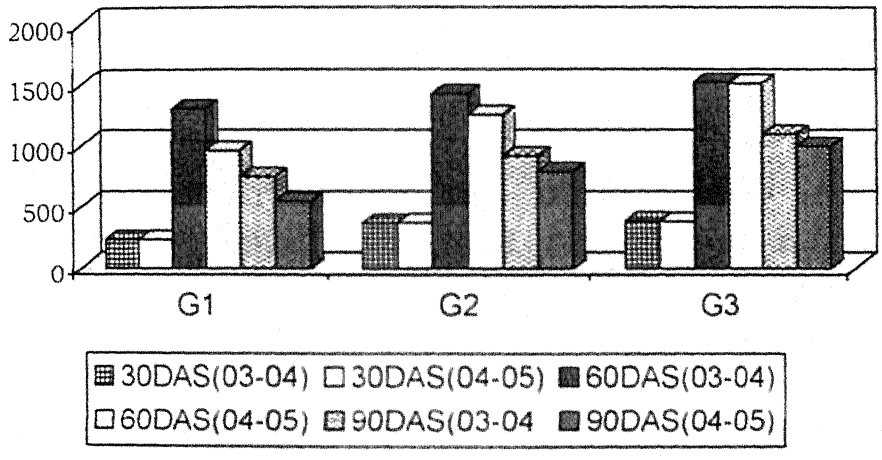
In 2003-04 year, interaction $D_2G_2V_2$ increased more number of functional leaves/plant which was at par with $D_1G_2V_2$ and significantly higher over $D_1G_2V_3$, $D_2G_3V_2$, $D_3G_3V_2$ etc, respectively.

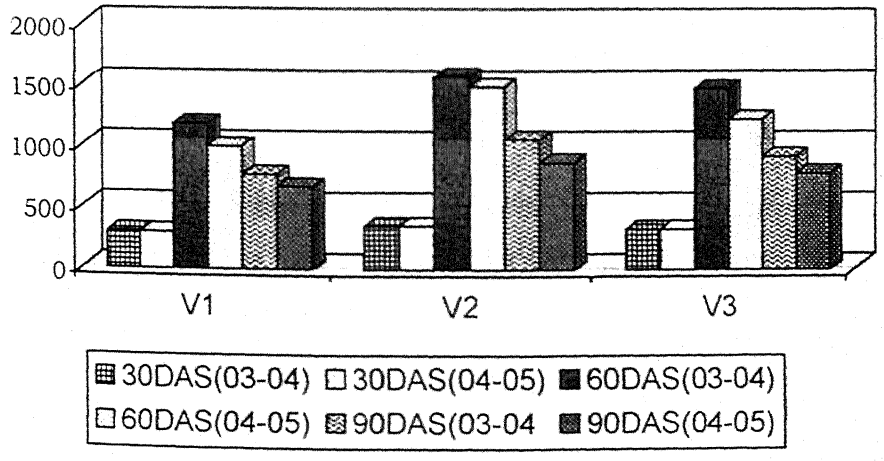
Table - 10 : Leaf area (Cm^2) as influenced by different treatments.

Treatments	Days after sowing								
	30			60			90		
Date of sowing	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
D_1 (10 Oct.)	314.55	313.51	314.03	1479.53	1402.66	1441.09	929.42	839.66	884.54
D_2 (25 Oct.)	429.09	426.76	427.92	1459.31	1425.87	1442.59	962.11	838.53	900.32
D_3 (10 Nov.)	240.91	239.87	240.39	1301.76	889.98	1095.87	863.66	649.89	756.77
SE ±	6.04	1.58		20.24	54.35		13.02	50.74	
C.D. at 5%	16.77	4.40		56.20	150.89		36.15	140.88	
Planting geometry (Cm)									
G_1 (30x15Cm)	231.17	230.13	230.65	1299.31	956.77	1128.04	745.27	545.08	645.17
G_2 (45x15Cm)	367.33	368.00	317.66	1421.26	1251.57	1336.41	913.33	790.01	851.67
G_3 (60x15Cm)	385.05	382.02	383.53	1519.03	1510.17	1514.60	1096.60	992.98	1044.79
SE ±	4.60	3.46		22.29	30.87		8.80	34.09	
C.D. at 5%	9.25	6.96		44.82	62.07		17.70	68.55	
Varieties									
V_1 (Varuna)	300.96	298.08	299.52	1187.59	997.68	1092.63	771.53	672.49	772.01
V_2 (Pusa bold)	352.99	353.11	353.05	1575.39	1491.73	1533.56	1063.48	871.09	967.28
V_3 (Jagannath)	329.90	328.95	329.42	1476.62	1229.11	1352.86	920.19	784.51	852.35
SE ±	4.60	3.46		22.29	30.87		8.80	34.09	
C.D. at 5%	9.25	6.96		44.82	62.07		17.70	68.55	
C.V. (%)	5.15	3.89		5.79	9.15		3.52	16.14	

Fig.7 : Leaf area (Cm^2) as influenced by different treatments.







In 2004-05 year, the number of functional leaves/plant was recorded maximum in $D_2G_2V_2$ but it was at par with $D_1G_1V_3$ and $D_1G_1V_2$ and significant over $D_2G_1V_3$, $D_1G_2V_2$, $D_2G_3V_2$, $D_2G_1V_2$ etc. respectively. The lowest value was recorded in $D_3G_2V_3$ interaction in this regard.

LEAF AREA/PLANT (Cm^2)

The leaf area was computed and presented in table (10), fig. (7) and the analysed data are given in appendix (IV)

It is evident from table (10) and fig. (7) that leaf area/ plant was increased abruptly up to 60 days age of crop. After that it decline up to 90 days observation.

EFFECT OF SOWING DATES:

The presented table (10) showed that maximum leaf area/plant was recorded in D_2 (25 Oct.) sowing date which was significantly more over D_3 (10 Nov.) at all the stages of observations in both the years. The value in order to D_2, D_1 and D_3 sowing dates, respectively.

EFFECT OF PLANTING GEOMETRIES:

The increased planting space/plant in both the years were also significantly increased leaf area/plant at all the observations. The significantly more value was recorded in G_3 (60x15 Cm) followed by G_2 (45x15 cm) and G_1 (30x15 cm) planting geometries, respectively.

PERFORMANCE OF VARIETIES:

It is revealed in table (10) that significantly maximum leaf area/plant (Cm^2) was recorded in V_2 (Pusa bold) variety over V_3 (Jagannath) and V_1 (Varuna) variety in both the years at all the observations and mean value also.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations on leaf area (Cm^2) as follows.

Table-10(a): Leaf area at 90 days as affected by interaction DxV in 2004-2005.

DxV	V_1	V_2	V_3
D_1	791.08	832.85	895.04
D_2	702.36	1009.85	803.36
D_3	524.01	770.56	655.96
SE ± 69.99		C.D. at 5% 168.90	

The data showed that significantly more leaf area (Cm^2) was recorded in D_2V_2 interaction followed by D_1V_3, D_1V_2, D_2V_3 etc. respectively. The significantly lowest value was recorded in D_3V_1 interaction.

Table(10b): Leaf area (Cm^2) at 90 days as affected by Interaction DxGxV in 2004-2005.

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	602.39	629.14	585.51	812.37	667.25	949.76	958.50	1202.95	1151.87
D_2	575.74	627.04	590.84	634.29	1247.96	773.66	897.95	1154.55	1045.59
D_3	397.78	498.79	398.49	476.30	816.30	734.17	697.96	996.60	832.65
SE± 102.26				C.D. at 5% 205.61					

Reference to table (10b) revealed that more leaf area (Cm^2) was found in $D_2G_2V_2$ interaction which was at par with $D_1G_3V_2$, $D_2G_3V_2$, $D_1G_3V_3$ and $D_2G_3V_3$ and significant over other interactions with the lowest values in $D_3G_1V_1$ interactions.

FRESH WEIGHT/PLANT (g):

The data on fresh weight/plant (g) are recorded and presented in table (11), depicted in fig. (8) and the statistically analysed data are given in appendix (V)

It is showed in table (11) and fig. (8) that fresh weight per plant (g) was continuously increased abruptly up to harvest.

EFFECT OF SOWING DATES:

The data revealed in table (11) that fresh weight/plant (g) was recorded significantly maximum in sowing date D_2 (25 Oct.) at all the stages of observations in both the years except with D_1 (10 Oct.) sowing date at 60 and 90 days observations in the years 2004-05 and 2003-04 respectively . The D_1 date of sowing also superior to D_3 (10 Nov.) at all the stages in both the years in this regard.

EFFECT OF PLANTING GEOMETRIES:

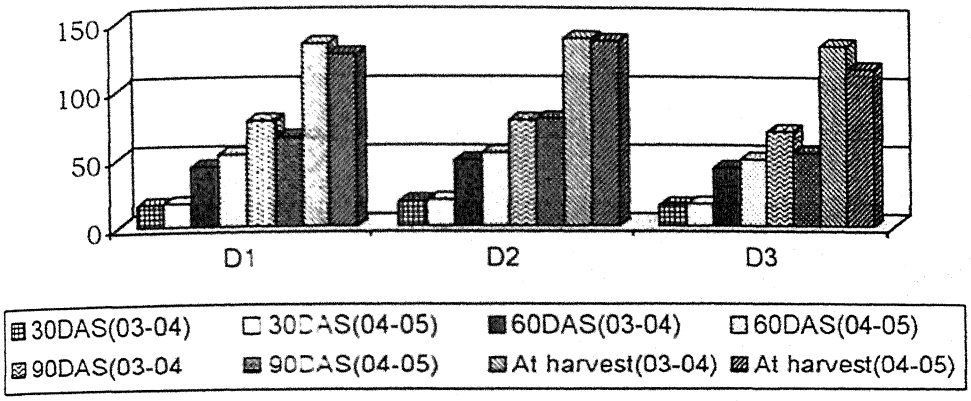
The increasing plant spaces were also increased fresh weight production per plant (g) in both the years and mean value also at all the observations. The both planting geometries such as G_3 (60x15 cm) and G_2 (45x15 cm) were increased significantly maximum values over G_1 (30x15 cm) row space in both the years but the G_3 and G_2 were at par with later stages of growth i.e. at 90 Days and at harvest.

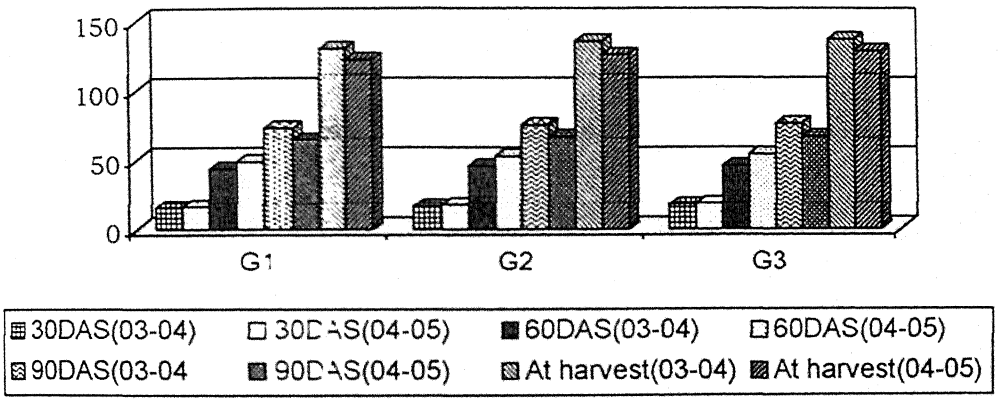
Table - 11 : Fresh weight/plant (g) as influenced by different treatments.

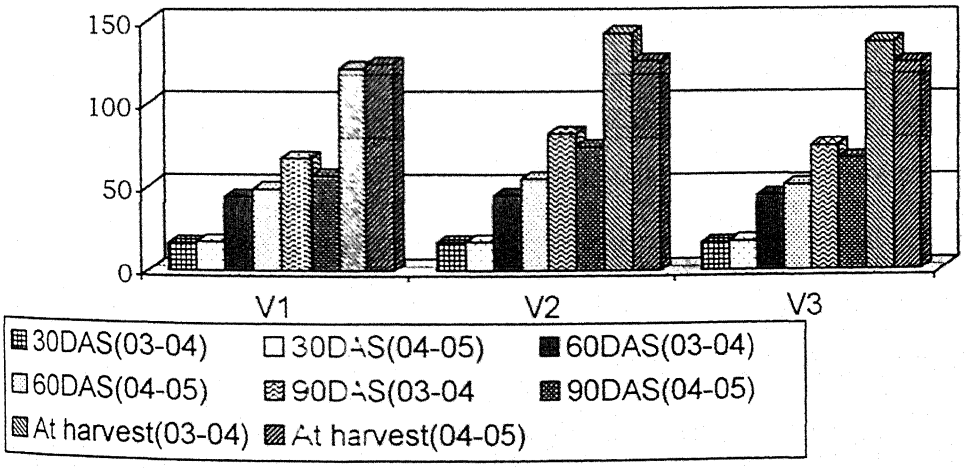
Treatments	Days after sowing											
	30			60			90			At harvest		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
Dates of sowing												
D_1 (10 Oct.)	16.61	17.35	16.98	44.18	52.85	48.52	77.54	65.95	71.74	133.42	125.65	129.54
D_2 (25 Oct.)	18.59	19.31	18.95	48.26	53.48	50.87	77.65	78.75	78.20	137.21	135.43	136.32
D_3 (10 Nov.)	15.47	16.32.	15.90	42.48	48.88	45.68	69.43	53.53	61.48	132.27	115.78	124.03
SE ±	0.24	0.38	-	0.29	0.53	-	0.35	0.46	-	0.85	1.07	
C.D. at 5%	0.68	1.04		0.81	1.48	-	0.97	1.28	-	2.37	2.98	
Planting geometry (Cm)												
G_1(30x15Cm)	15.76	16.26	16.01	43.67	48.74	46.21	73.30	64.43	68.86	130.53	122.40	126.47
G_2(45x15Cm)	16.86	17.81	17.34	45.58	52.60	49.09	75.35	66.80	71.07	135.55	125.96	130.76
G_3(60x15Cm)	18.04	18.91	18.48	45.67	53.86	49.77	75.96	67.00	71.48	136.82	128.48	132.65
SE ±	0.33	0.33	-	0.46	0.60	-	0.81	0.56	-	1.38	1.54	-
C.D. at 5%	0.66	0.67	-	0.93	1.20	-	1.62	1.12	-	2.77	3.10	
Varieties												
V_1 (Varuna)	16.79	17.57	17.18	44.65	49.08	46.87	67.42	57.13	62.28	122.17	124.76	123.44
V_2(Pusa bold)	17.07	17.75	17.41	45.30	55.03	50.17	82.58	74.01	78.30	143.12	126.60	134.86
V_3(Jagannath)	16.80	17.67	17.24	44.97	51.10	48.04	74.62	67.08	70.85	137.66	125.47	131.57
SE ±	0.33	0.33		0.46	0.60		0.81	0.56		1.38	1.54	
C.D. at 5%	N.S.	N.S.		N.S.	1.20		1.62	1.12		2.77	3.10	
C.V. (%)	7.19	6.92		3.76	4.24		4.25	3.08		3.76	4.51	

N.S. = Non Significant.

Fig.8 : Fresh weight / plant (g) as influenced by different treatments.







PERFORMANCE OF VARIETIES:

The presented data showed that at early stages there was not significant variation between varieties in increasing fresh weight/plant (g) but at later stages the variety V_2 (Pusa bold) produced maximum and significantly more values over V_1 (Varuna) in both the years. The values in order to V_2, V_3 and V_1 varieties, respectively.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations on fresh weight/plant (g) are as follows.

Table(11a): Fresh weight/plant(g) at 90 days as affected by interaction D x G.

DxG	2003-04			2004-05		
	G_1	G_2	G_3	G_1	G_2	G_3
D_1	77.89	77.43	77.27	65.59	68.32	63.92
D_2	78.09	80.42	74.42	79.85	80.82	75.56
D_3	63.92	70.02	74.36	54.94	31.85	53.80
	SE ± 1.19 CD at 5% 2.48			SE± 0.91 CD at 5% 2.01		

Reference to table (11a) found that fresh weight/plant (g) in both the years was recorded maximum in D_2G_2 interaction which was at par with D_2G_1 and significant over other interactions with the minimum value in D_3V_1 and D_3G_2 interactions in 1st and 2nd years, respectively.

Tbale-(11b):Fresh weight/plant (g) at 90days as affected by Interaction DxV.

DxV	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
D_1	62.69	79.23	66.37	77.56	79.99	78.68
D_2	68.02	85.23	79.67	47.18	82.69	69.95
D_3	71.53	83.26	77.79	46.63	61.35	52.61
	SE ± 1.19 CD at 5% 2.48			SE± 0.91 CD at 5% 2.01		

In 2003-04. the fresh weight/plant (g) was recorded maximum in D_2V_2 interaction which was at par with D_3V_2 and significant over D_2V_3, D_1V_2, D_3V_3 etc,respectively.

Table 11(b) revealed in 2004-05 year that D_2V_2 interaction also increased maximum value which was non significant to D_1V_2 and D_1V_3 and significant over D_1V_1, D_2V_3, D_3V_3 etc respectively with the minimum value in D_3V_1 interaction.

Table(11c):Fresh weight/plant (g) at 90days as affected in Interaction GxV in 2004-05.

GxV	V_1	V_2	V_3
G_1	57.53	74.55	68.30
G_2	56.56	77.94	67.39
G_3	57.29	70.44	65.55
SE ± 0.96		C.D. at 5% 1.93	

Reference to table (11c) showed that significantly maximum fresh weight/plant was in G_2V_2 interaction followed by G_1V_2, G_3V_2, G_1V_3 and G_2V_3 etc. respectively.

Table(11d):Fresh weight/plant (g) at 90days as affected by Interaction DxGxV .

2003-04

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	57.97	74.07	59.72	63.95	72.87	67.03	66.16	84.24	72.67
D_2	65.84	80.81	87.61	79.37	89.91	83.67	65.35	84.98	72.92
D_3	73.96	85.53	76.20	66.74	76.48	81.60	73.61	82.64	75.58
SE ± 2.42					C.D. at 5% 4.87				

2004-05

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	76.85	80.87	81.84	80.38	81.00	81.08	75.46	78.11	73.13
D_2	48.32	82.40	66.06	44.77	87.79	72.40	48.45	71.89	71.40
D_3	47.42	60.39	57.00	44.54	62.32	48.70	47.95	61.34	52.11
SE ± 1.67					C.D. at 5% 3.35				

It is revealed in table (11d) that $D_2G_2V_2$ interaction was recorded maximum fresh weight/plant (g) in both the years. In 2003-04, the respectively interaction was at par with $D_2G_1V_3$ while in 2004-05 it was significantly superior over other interactions. The lowest value were recorded in $D_3G_2V_1$ interactions in both the years.

Table(11e): Fresh weight/plant (g) at harvest as affected by Interaction DxG in 2003-04.

DxG	G_1	G_2	G_3
D_1	137.05	137.11	137.46
D_2	126.48	136.07	137.69
D_3	128.05	133.46	135.28
SE ± 2.13		C.D. at 5% 4.54	

Reference to table (11e) showed that fresh weight at harvest recorded maximum in D_2G_3 interaction which was significant only D_3G_1 and D_2G_1 interactions,respectively.

DRY WEIGHT/PLANT(g):

The data on dry matter production/plant (g) are recorded and presented in table (12), illustrated in fig. (9) and the statistically analysed data are given in appendix (VI).

Reference to table (12) showed that dry matter accumulation/plant (9) was increased abruptly up to 60 days and thereafter, it increased slowly up to harvest continuously.

EFFECT OF SOWING DATES:

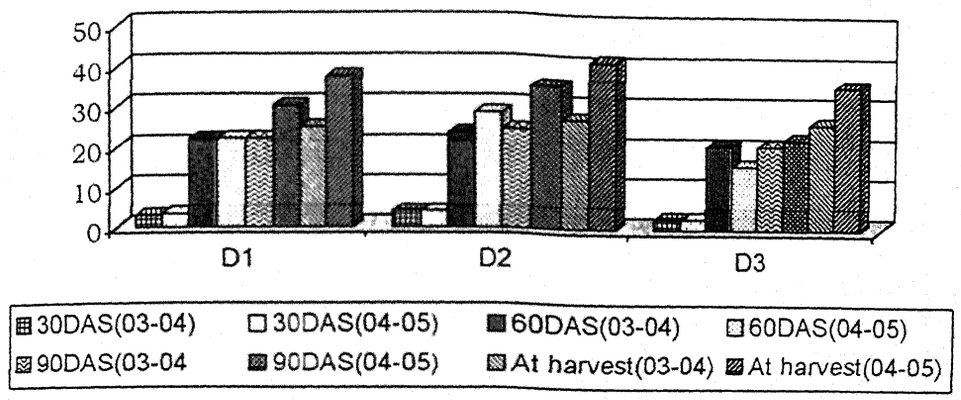
The presented table (12) showed that different sowing dates were significantly differed among each other in increasing dry matter accumulation/plant (g) at different stages of observations in both the years except D_1 (10 Oct.) and D_3 (10 Nov.) in 2003-04. The significantly maximum value was recorded in D_2 (25 Oct.) sowing date followed by D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates,respectively.

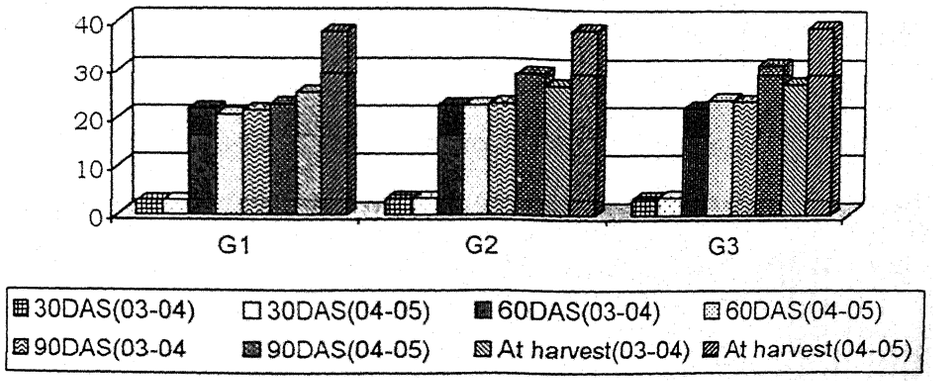
Table - 12 : Dry weight/plant (g) as influenced by different treatments.

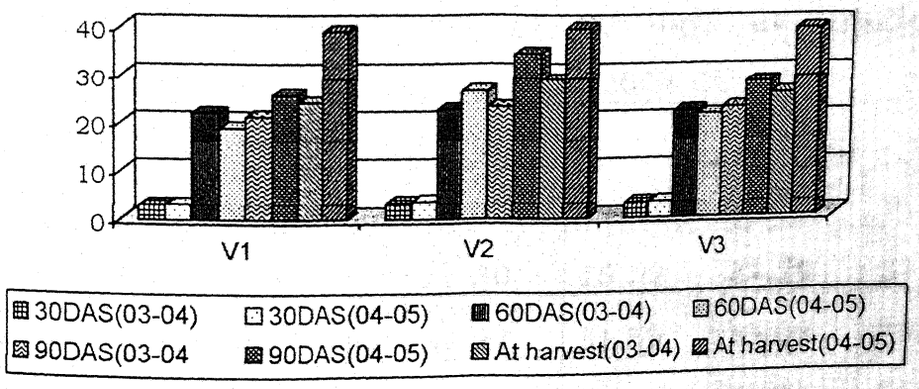
Treatments	Days after sowing											
	30			60			90			At harvest		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
Date of sowing												
D_1 (10 Oct.)	3.05	3.41	3.23	22.13	22.22	22.17	22.31	30.23	26.27	25.13	37.73	31.43
D_2 (25 Oct.)	4.18	4.16	4.17	23.79	28.69	26.24	24.77	35.42	30.09	27.27	41.55	34.41
D_3 (10 Nov.)	2.66	2.68	2.67	21.12	16.11	18.61	21.17	22.78	21.97	26.43	35.74	31.08
SE ±	0.09	0.08	-	0.43	0.28	-	0.33	0.65	-	0.32	0.30	
C.D. at 5%	0.25	0.23		1.20	0.78	-	0.92	1.80	-	0.88	0.84	
Planting geometry (Cm)												
G_1(30x15Cm)	2.93	3.00	2.97	21.73	20.59	21.16	21.51	27.76	24.63	25.17	37.74	31.45
G_2(45x15Cm)	3.36	3.45	3.41	22.54	22.57	22.55	22.90	29.41	26.15	26.58	38.31	32.44
G_3(60x15Cm)	3.60	3.79	3.70	22.17	23.86	23.31	23.53	31.25	27.39	27.09	38.96	33.02
SE ±	0.05	0.08	-	0.31	0.30	-	0.27	0.55	-	0.37	0.45	-
C.D. at 5%	0.11	0.17	-	0.62	0.60	-	0.54	1.06	-	0.75	0.90	
Varieties												
V_1 (Varuna)	3.16	3.21	3.19	22.01	18.90	20.45	21.19	25.73	23.46	24.15	39.01	31.58
V_2(Pusa bold)	3.43	3.63	3.53	22.72	26.57	24.64	23.26	34.43	28.84	28.85	39.61	34.23
V_3(Jagannath)	3.31	3.41	3.36	22.31	21.55	21.93	22.90	28.27	25.58	25.84	39.41	32.62
SE ±	0.05	0.08		0.31	0.30		0.27	0.43		0.37	0.45	
C.D. at 5%	0.11	0.17		0.62	0.60		0.54	1.06		0.75	N.S.	
C.V. (%)	5.90	8.80		3.06	4.91		4.38	6.56		5.23	4.32	

N.S. = Non Significant.

Fig.9 : Dry weight/plant (g) as influenced by different treatments.







EFFECT OF PLANTING GEOMETRIES:

The dry matter production/plant (g) was significantly affected by different planting geometries in 60 days and 90 days observations in both the years. At 90 days and at harvest in the years 2003-04 and 2004-05 respectively was significantly differed between G_3 and G_2 planting geometries. The value in order to G_3, G_2 and G_1, respectively.

PERFORMANCE OF VARIETIES:

The variety V_2 (Pusa bold) increased maximum dry weight/plant (g) over other varieties such as V_3 (Jagannath) and V_1 (Varuna) respectively at all the stages of observations in both the years and mean value also. The respective variety V_2 was significantly superior in 30 days but it was at par with 60 and 90 days in V_3 (2003-04) and non significantly affected at harvest in 2004-05 years.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations on dry weight/plant (g) as follows.

Table(12a): Dry weight/plant(g) at 90 days as affected by Interaction DxG and DxV in 2004-05.

DxG	2004-05			2004-05		
	G_1	G_2	G_3	V_1	V_2	V_3
D_1	29.69	34.68	26.30	25.52	37.70	27.45
D_2	35.85	36.12	34.27	31.59	39.03	35.62
D_3	22.68	22.95	22.70	20.06	26.54	21.72
	SE ± 1.99 CD at 5% 2.31			SE± 0.99 CD at 5% 2.31		

Table (12a) indicated that interaction D_2G_2 recorded maximum fresh weight/plant (g) over other interactions. The D_2G_2 was at par with D_2G_1, D_1G_2 and D_2G_3 and significant over other interactions. In DxV interactions the dry weight/plant (g) was found in D_2V_2 with non significant difference to D_1V_2 and significantly superior over D_2V_3, D_2V_1, D_1V_3 etc, respectively.

Table(12b):Dry weight/plant (g) at 90 days as affected by Interaction GxV in 2004-05.

2004-2005			
G x V	V_1	V_2	V_3
G_1	23.93	32.38	26.98
G_2	26.03	32.80	29.30
G_3	27.21	38.02	28.51
SE ± 0.91		C.D. at 5% 1.83	

Reference to table (12b) found that G_3V_2 interaction significantly maximum dry weight/plant (g) over G_2V_2, G_1V_2, G_2V_3, G_3V_3 etc, respectively. The significant lowest value was recorded in G_1V_1 interaction.

Table(12c): Dry weight/plant (g) at 90 days as affected by interaction DxGxV in year 2004-05.

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	30.40	39.45	37.70	34.28	38.97	35.10	30.09	38.67	34.06
D_2	27.22	34.10	27.75	27.31	48.14	28.60	22.03	30.88	26.01
D_3	20.47	25.10	22.46	20.05	26.95	21.84	19.66	27.58	20.86
SE ± 1.58				C.D. at 5% 3.18					

It is showed in table (12c) that interaction $D_2G_2V_2$ recorded significantly maximum dry weight/plant (g) over other interactions such as $D_1G_1V_2$, $D_1G_2V_2$, $D_1G_3V_2$, $D_1G_1V_3$ etc. respectively. The significantly lowest values were recorded in $D_3G_1V_1$ interactions.

Table(12d):Dry weight/plant(g) at harvest as affected by interaction (DxG) and (DxV) in 2003-04 year.

DxG	2003-04			2003-04		
	G_1	G_2	G_3	V_1	V_2	V_3
D_1	23.31	26.74	25.32	24.32	26.53	24.52
D_2	26.97	27.32	27.51	24.00	31.68	26.12
D_3	25.21	25.65	28.43	24.12	28.32	26.85
	SE ± 0.62 CD at 5% 1.36			SE± 0.62 CD at 5% 1.36		

The data showed that D_3G_3 interaction increased maximum dry weight/plant (g) which was at par with D_2G_3, D_2G_2, and significant over D_2G_1, D_1G_2, D_3G_2 etc, respectively.

In interaction DxV, the interaction D_2V_2 produced significantly maximum dry weight/plant. Over other combinations such as D_3V_2, D_3V_3, D_1V_2, D_2V_3 etc respectively with the minimum value in D_3V_1 interaction.

NUMBER OF BRANCHES/PLANT:

The number of primary, secondary and tertiary branches per plant were recorded and presented in table (13), fig. (10) and the statistically analysed data are given in appendix (VII).

Table - 13: Number of branches / plant as influenced by different treatments.

Treatments	No. of primary branches			No. of secondary branches			No. of tertiary branches		
Date of sowing	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
D_1 (10 Oct.)	6.43	6.89	6.66	16.48	16.25	16.36	9.96	9.68	9.82
D_2 (25 Oct.)	6.70	7.22	6.96	17.56	17.52	17.54	10.55	10.41	10.48
D_3 (10 Nov.)	6.41	6.84	6.62	15.02	15.08	15.05	9.71	9.28	9.49
SE ±	0.13	0.17		0.50	0.16		0.16	0.14	
C.D. at 5%	N.S.	N.S.		1.40	0.46		0.44	0.40	
Planting geometry (Cm)									
G_1 (30x15Cm)	5.54	6.01	5.78	14.37	14.33	14.35	8.29	7.84	8.06
G_2 (45x15Cm)	6.49	6.14	6.32	16.45	16.16	16.30	10.01	9.84	9.92
G_3 (60x15Cm)	7.51	7.01	7.26	18.24	18.35	18.29	11.92	11.69	11.80
SE ±	0.15	0.20		0.43	0.20		0.26	0.14	
C.D. at 5%	0.31	0.39		0.86	0.39		0.52	0.25	
Varieties									
V_1 (Varuna)	6.15	6.61	6.38	15.78	15.69	15.73	9.41	9.07	9.24
V_2 (Pusa bold)	6.89	7.44	7.16	16.87	16.79	16.83	10.51	10.35	10.43
V_3 (Jagannath)	6.51	7.11	6.81	16.41	16.35	16.38	10.30	9.96	10.13
SE ±	0.15	0.20		0.43	0.20		0.26	0.14	
C.D. at 5%	0.31	0.39		0.86	0.39		0.52	0.28	
C.V. (%)	8.66	10.22		9.66	4.40		9.49	5.21	

Fig.10: Number of Primary branches/plant as influenced by different treatments.

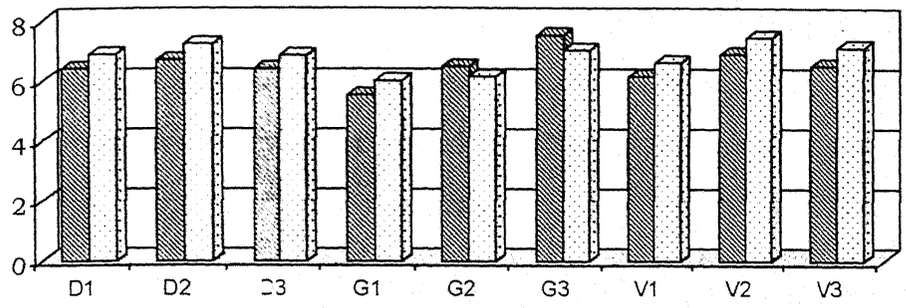


Fig..10:No. of Secondary branches /plant as influenced by different treatments.

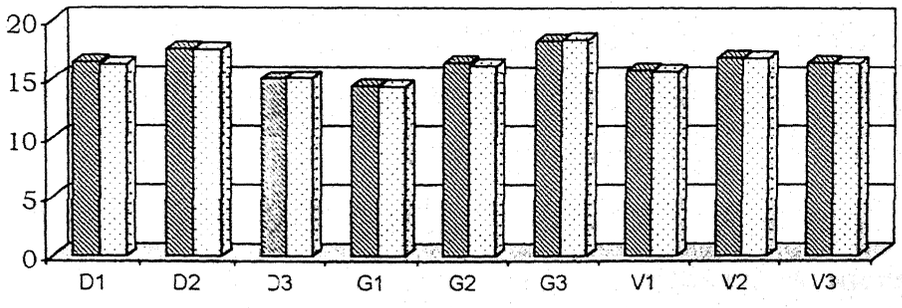
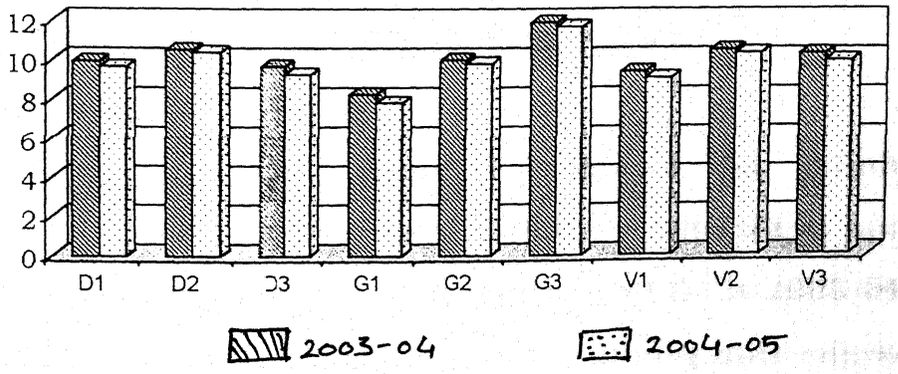


Fig..10: No. of Tertiary branches /plant as influenced by different treatments.



NUMBER OF PRIMARY BRANCHES/PLANT:

EFFECT OF SOWING DATES:

The number of primary branches/plant was non significantly affected by different sowing dates in both the years. The more values were recorded in D_2 (25 Oct.) sowing date followed by D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively in both the years.

EFFECT OF PLANTING GEOMETRIES:

The wider planting space i.e. G_3 (60x15cm) was significantly increased more number of primary branches/plant in both the years over G_2 (45x15cm) and G_1 (30x15cm) planting geometries, respectively. The G_2 was also significantly superior over G_1 in 2003-04 observations in this regard.

PERFORMANCE OF VARIETIES:

The varieties was significantly differed in increasing number of primary branches/plant among each other except V_2 and V_3 in 2004-05 observation. The value in order to V_2 (Pusa bold) V_3 (Jagannath) and V_1 (Varuna) varieties,respectively.

NUMBER OF SECONDARY BRANCHES/PLANT:

EFFECT OF SOWING DATES:

The presented table (13) showed that number of secondary branches/plant was significantly affected in both the years at different sowing dates except D_2 and D_1 in 2003-04. The more value was recorded in D_2 (25 Oct.) sowing date followed by D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates,respectively.

EFFECT OF PLANTING GEOMETRIES:

The different planting geometries were significantly differed in increasing number of secondary branches/plant in both the years among each other. The G_3 (60x15) recorded significantly more value over G_2 (45x15 cm) and G_1 (30x15 cm), respectively.

PERFORMANCE OF VARIETIES:

The Pusa bold (V_2) variety increased more number of secondary branches/plant over other varieties in both the years. The different varieties were significantly differed among each other except V_2 (Pusa bold) and V_3 (Jagannath) in 2003-04 year.

SIGNIFICANT INTERACTIONS:

The interaction effect in respect to number of secondary branches/plant as affected by different treatment combinations are as follows.

Table(13a): No. of siliqua bearing secondary branches as influenced by interaction of sowing dates and planting geometries DxG 2004-05.

D x G	G_1	G_2	G_3
D_1	13.81	16.25	18.87
D_2	16.09	17.04	19.40
D_3	13.06	15.19	16.97
SE ± 0.32		C.D. at 5% 0.70	

The presented showed that more number of secondary branches per plant was recorded in D_2G_3 interaction which was at par with D_1G_3 and significant over D_2G_2, D_3G_3, D_1G_2 etc respectively with significantly lowest value in D_3G_1.

Table(13b):Number of secondary branches/plant as affected by interaction DxGxV in 2004-05.

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	12.05	15.68	13.69	16.21	17.18	15.36	18.19	18.27	19.58
D_2	15.90	16.22	16.17	16.45	17.47	17.20	18.47	20.27	19.46
D_3	12.87	13.21	13.12	14.45	15.64	15.47	16.63	17.15	17.13
SE ± 0.33					C.D. at 5% 0.67				

Table (13b) indicated that $D_2G_3V_2$ interaction produced significantly more number of secondary branches/plant followed by $D_1G_3V_3$, $D_2G_3V_3$, $D_2G_3V_1$, $D_1G_3V_1$ etc. interactions. The lowest value was recorded in $D_1G_1V_1$ interaction.

NUMBER OF TERTIARY BRANCHES/PLANT:

EFFECT OF SOWING DATES:

Table (13) showed that D_2 (25 Oct.) sowing date produced significantly higher number of tertiary branches/plant over other sowing dates in both the years. The sowing dates such as D_1 (10Oct.) and D_3 (10 Nov.) were at par in this regard in both the years.

EFFECT OF PLANTING GEOMETRIES:

The different planting geometries were significantly differed in increasing number of tertiary branches/plant in both the years. The value in order to G_3 (60x15 cm), G_2 (45x15 cm) and G_1 (30x15 cm) planting geometries,respectively.

PERFORMANCE OF VAREITIES:

The number of tertiary branches/plant was recorded more in variety V_2 (Pusa bold) followed by other varieties in both the years. The varieties such as V_2 (Pusa bold) and V_3 (Jagannath) were at par in 2003-04 year but in 2004-05 each varieties were significantly affected in this regard. The order of the curves was as $V_2>V_3>V_1$.

SIGNIFICANT INTERACTIONS:

The interaction effect in respect to number of tertiary branches/plant between DxG was significant.

Table(13c): Number of tertiary branches/plant as affected by interaction DxG.

2004-05			
D x G	G_1	G_2	G_3
D_1	7.71	9.55	11.78
D_2	8.92	10.16	12.16
D_3	6.89	9.60	11.12
SE ± 0.24		C.D. at 5% 0.55	

Reference to table (13c) indicated that number of tertiary branches/plant as recorded more in D_2G_3 interaction which was at par with D_1G_3 and significantly more over D_3G_3,

D_2G_2, D_3G_2, D_1G_2 etc. respectively with the lowest value in D_3G_1 interaction.

DAYS TO 50% FLOWERING AND DAYS OF 50% MATURITY:

The data on 50% flowering and 50% maturity are counted, recorded and presented in table (14), illustrated in fig.(11) and the analysed data are given in appendix (VIII).

DAYS TO 50% FLOWERING:

EFFECT OF SOWING DATES:

The different sowing dates were significantly differed among each other in days to 50% flowering in both the years. The sowing date D_2 (25 Oct.) increased significantly more days followed by D_1 (10Oct.) and D_3 (10 Nov.), respectively.

EFFECT OF PLANTING GEOMETRIES:

The days to 50% flowering was reduced with increasing planting geometries in both the years observations. The planting geometry G_1 (30x15 cm) was at par with G_2 (45x15 cm) in 2003-04 but it was significantly superior over other planting geometries in 2004-05 year. The G_2 and G_3 planting spaces were also non significant in this regard.

PERFORMANCE OF VARIETIES:

The variety V_2 (Pusa bold) was increased more days to 50% flowering over other varieties. The variety V_2 (Pusa bold) was at par with V_3 (Jagannath) in 2003-04 year but in 2004-05 it was significantly superior over other varieties. The varieties such as V_3 (Jagannath) and V_1 (Varuna) were non significant in this regard in both the years.

Table - 14 : Days to 50% flowering and 50% maturity as influenced by different treatments.

Treatments	Days of 50% flowering			Days of 50% maturity		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean
Date of sowing						
D_1 (10 Oct.)	53.89	53.89	53.89	114.00	111.70	112.85
D_2 (25 Oct.)	55.63	59.96	59.80	114.81	115.63	115.22
D_3 (10 Nov.)	46.00	45.19	45.60	112.04	110.81	111.43
SE ±	0.63	0.38		0.75	0.51	
C.D. at 5%	1.75	1.05		2.08	1.42	
Planting geometry (Cm)						
G_1(30x15Cm)	53.78	53.52	53.65	113.56	111.52	112.54
G_2(45x15Cm)	53.63	53.30	53.47	113.78	112.74	113.26
G_3(60x15Cm)	52.11	52.22	52.17	113.52	113.89	113.71
SE ±	0.42	0.45		0.98	0.55	
C.D. at 5%	N.A.	0.91		N.S.	1.10	
Varieties						
V_1 (Varuna)	50.44	50.52	50.48	113.11	111.78	112.45
V_2(Pusa bold)	55.89	56.00	55.95	114.85	113.59	114.22
V_3(Jagannath)	53.19	52.52	52.86	112.89	112.78	112.84
SE ±	0.42	0.45		0.98	0.55	
C.D. at 5%	0.85	0.91		N.S.	1.10	
C.V. (%)	2.92	3.14		3.14	1.79	

N.S. = Non Significant

Fig.11: Days to 50% flowering as influenced by different treatments.

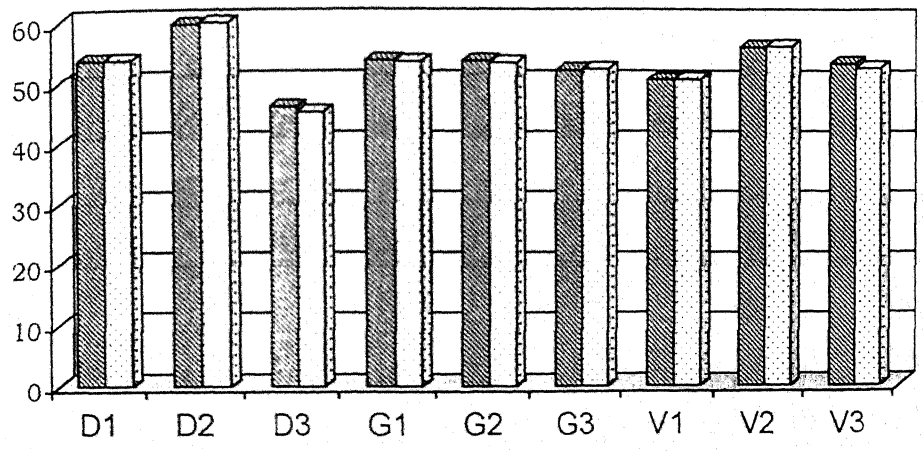
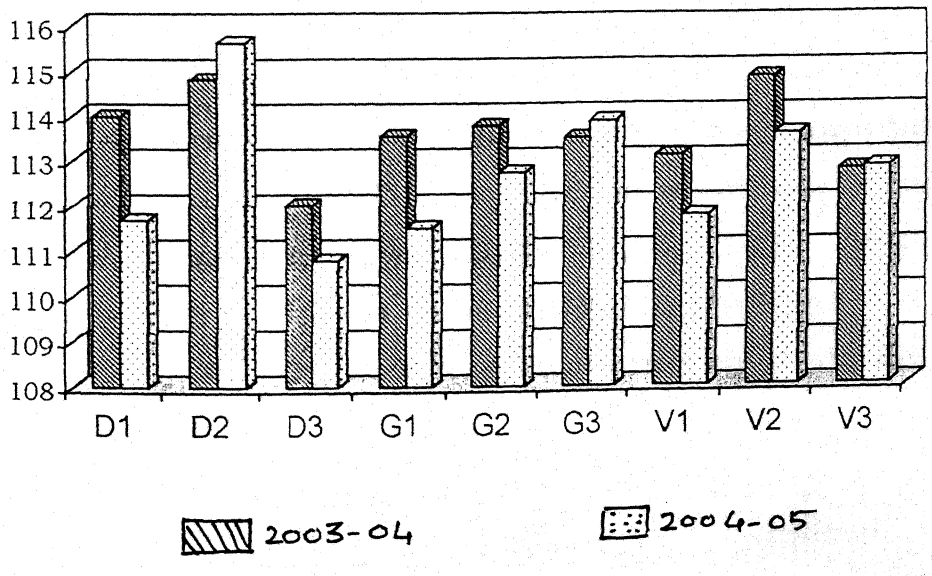


Fig.11: Days to 50% Maturity as influenced by different treatments.



SIGNIFICANT INTERACTIONS:

The interactions effect in respect to days of 50% flowering between different treatment combinations are as follows.

Table(14a): Days to 50% flowering as affected by interaction DxG in both the years.

DxG	2003-04			2004-05		
	G_1	G_2	G_3	G_1	G_2	G_3
D_1	60.00	62.44	56.44	61.22	62.22	56.44
D_2	54.22	53.44	54.00	54.44	53.66	53.55
D_3	46.66	45.44	45.88	44.88	44.00	46.66
	SE ± 0.87 CD at 5% 2.10			SE± 0.74 CD at 5% 1.64		

Reference to table (14a) in year 2003-04 showed that D_1G_2 interaction [illegible] days to 50% flowering over other interactions such as D_1G_1, D_1G_3, D_2G_1, D_2G_3 etc, respectively.

In year 2004-05 indicated that more days to 50% flowering was recorded in D_1G_2 interaction which was at par with D_1G_1 and significant over D_1G_3, D_2G_1, D_2G_2, D_2G_3 etc. respectively with the lowest value in D_3G_2 interaction.

Table(14b): Days to 50% flowering as affected by interaction DxV and GxV in 2004-05 year.

DxV	2004-05			GxV	2004-05		
	V_1	V_2	V_3		V_1	V_2	V_3
D_1	58.22	61.22	60.44	G_1	50.22	57.55	52.77
D_2	51.22	57.44	53.00	G_2	51.77	55.33	52.77
D_3	42.11	49.33	44.11	G_3	49.55	55.11	52.00
SE ± 0.74		C.D. at 5% 1.64		SE ± 0.78		C.D. at 5% 1.58	

In interaction DxV, indicated that maximum days to 50% flowering was recorded in D_1V_2 interaction with non significant in D_1V_3 and significant over D_1V_1, D_2V_2, D_2V_3 etc. with the lowest value in D_3V_1 in this regard.

Reference to interaction GxV, showed that significantly more days to 50% flowering was found in G_1V_2 interaction over G_2V_2, G_3V_2, G_1V_3, G_2V_3 etc. with the lowest value in G_3V_1.

Table(14c): Days to 50% flowering as affected by interaction DxGxV in the year 2003-04.

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	56.66	63.00	60.33	60.33	63.66	63.33	53.00	60.00	56.33
D_2	51.66	56.66	54.33	49.66	57.33	53.33	53.00	55.33	53.66
D_3	44.33	50.33	45.33	43.33	47.33	45.66	42.00	49.33	46.33
SE ± 1.56				C.D. at 5% 3.13					

Reference to table (14c) found that more days to 50% flowering was recorded in $D_1G_2V_2$ which was at par with $D_1G_2V_3$ and $D_1G_1V_2$ and significant over $D_1G_1V_3$, $D_1G_2V_1$, $D_1G_3V_2$ etc, respectively. The lowest value was in interaction $D_3G_3V_1$ in this regard.

DAYS TO 50% MATURITY:

EFFECT OF SOWING DATES:

The sowing date D_1 (10 Oct.) increased significantly more days over D_3 (10 Nov.) date in both the years.

But the sowing dates such as D_1 and D_2 in 2003-04 and D_2 and D_3 in 2004-05 were at par in this regard.

EFFECT OF PLANTING GEOMETRIES:

The days to 50% flowering was increased with increasing planting geometries in both the years of observations. The planting geometries were at par in 2003-04 and significantly differed in 2004-05 in this regard. The mean value was also more in wider planting space in both the years.

PERFORMANCE OF VARIETIES:

The variety V_3 (Jagannath) significantly more days to 50% maturity over V_1 (Varuna) variety in both the years. The varieties such as V_2V_3 and V_2, V_1 were non significant in this regard in different observations of both years.

SIGNIFICANT INTERACTIONS:

The interaction effect in respect to days to 50% maturity between different treatment combinations are as follows.

Table(14d):Days to 50% maturity as affected by interaction DxG and DxV in 2004-05 year.

	DxG			DxV		
	G_1	G_2	G_3	V_1	V_2	V_3
D_1	109.55	110.22	112.66	109.88	111.44	111.11
D_2	116.11	115.55	115.22	117.33	114.66	114.88
D_3	112.55	108.77	113.77	111.11	109.22	114.77
	SE ± 0.93 CD at 5% 2.08			SE± 0.93 CD at 5% 2.08		

In interaction DxG showed that days of 50% maturity was more in D_2G_1 with non significant to D_2G_2 and D_2G_3 and significant over other interactions with lowest days in D_1G_1 interaction.

It is showed in interaction DxV, that D_2V_1 significantly increased more days of 50% maturity over other interactions such as D_2V_3, D_3V_3, D_2V_2 etc. respectively with the significantly lowest value in D_1V_1.

Table(14e): Days to 50% maturity as affected by interaction GxV in 2004-05 year.

G x V	V_1	V_2	V_3
G_1	112.88	111.55	113.77
G_2	109.00	112.66	112.88
G_3	116.44	111.11	114.11
SE ± 0.95		C.D. at 5% 1.91	

It is revealed in table (14e) that days to 50% maturity was recorded significantly more in G_3V_1 interaction followed by G_3V_3, G_1V_3, G_1V_1, G_2V_3 etc, respectively.

Table(14f): Days to 50% maturity as affected by interaction DxGxV (2004-05).

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	107.33	109.33	112.00	106.00	114.33	110.33	116.33	110.67	111.00
D_2	112.67	110.00	115.00	105.33	108.67	112.33	115.33	109.00	117.00
D_3	118.67	115.33	114.33	115.67	115.00	116.00	117.67	113.67	114.33
SE ± 1.64				C.D. at 5% 3.30					

Reference to table (14f) indicated that interaction $D_3G_1V_1$ recorded more days to 50% maturity over others. The respective interaction was at par with $D_3G_3V_1$, $D_1G_3V_1$, $D_3G_2V_3$, $D_3G_2V_1$ and significant over other interactions.

YIELD ATTRIBUTES:

The main yield attributing characters viz. number of siliquae/plant, weight of siliquae/plant (g), length of siliqua (cm), number of seeds/siliqua, weight of seeds/siliqua (mg) and weight of seeds/plant (g) are summarized, recorded and presented in table (15 to 16) and depicted in fig. (12 to 17). The statistically analysed data are given in appendix (IX).

NUMBER OF SILIQUAE/PLANT:

The data on number of siliquae/plant have been recorded and presented in table (15), fig.(12) and are given in appendix (IX).

EFFECT OF SOWING DATES:

The presented table (15a) revealed that D_2 (25 Oct.) sowing date produced maximum number of siliquae/plant over other sowing dates as D_1 (10 Oct.) and D_3 (10 Nov.), respectively in both the years. The respective sowing date was significantly superior over D_3 in both years and D_1 also in 2003-04 observation. The mean value was also maximum in D_2 sowing date.

EFFECT OF PLANTING GEOMETRIES:

The number of siliquae/plant was increased with increasing planting geometries in both the years. The G_3

Table - 15 : Yield attributing characters as influenced by different treatments.

Treatments	No. of siliquae/plant			Weight of siliquae/plant			Length of siliquae (Cm)		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
Date of sowing									
D_1 (10 Oct.)	414.81	330.96	372.88	47.63	37.07	42.33	5.16	5.31	5.23
D_2 (25 Oct.)	490.67	345.52	418.09	56.04	38.19	47.11	5.17	5.37	5.27
D_3 (10 Nov.)	408.15	310.85	359.50	44.37	33.96	39.16	5.05	5.21	5.13
SE ±	9.68	6.70	-	0.90	1.15	-	0.09	0.19	-
C.D. at 5%	26.88	18.61		2.50	3.20	-	N.S.	N.S.	-
Planting geometry (Cm)									
G_1(30x15Cm)	430.56	321.11	375.83	48.52	34.96	41.74	5.02	5.20	5.11
G_2(45x15Cm)	439.00	322.59	380.79	48.78	35.22	42.00	5.17	5.28	5.22
G_3(60x15Cm)	444.07	343.63	393.85	50.74	39.04	44.89	5.19	5.41	5.30
SE ±	10.57	9.23	-	0.85	0.77	-	0.13	0.13	-
C.D. at 5%	N.S.	18.56	-	1.71	1.55	-	N.S.	N.S.	
Varieties									
V_1 (Varuna)	406.19	318.85	362.52	43.00	35.52	39.26	5.01	5.28	5.14
V_2(Pusa bold)	493.56	338.22	415.89	53.81	37.41	45.61	5.30	5.30	5.30
V_3(Jagannath)	413.89	330.26	372.07	51.22	36.30	43.76	5.06	5.30	5.18
SE ±	10.57	9.23		0.85	0.77		0.13	0.13	
C.D. at 5%	21.25	18.56		1.71	1.55		0.26	N.S.	
C.V. (%)	8.87	10.31		6.34	7.76		9.55	8.21	

N.S. = Non Significant.

Fig. 12: No. of siliquae per plant as influenced by different treatments.

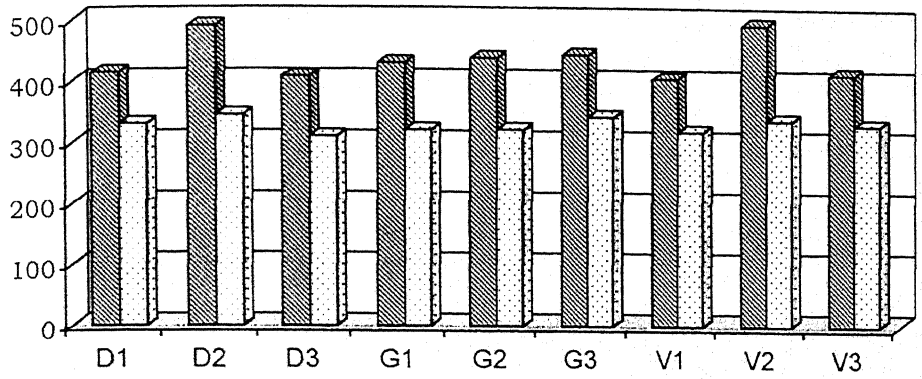


Fig. 13: Weight of siliquae (g) per plant as influenced by different treatments.

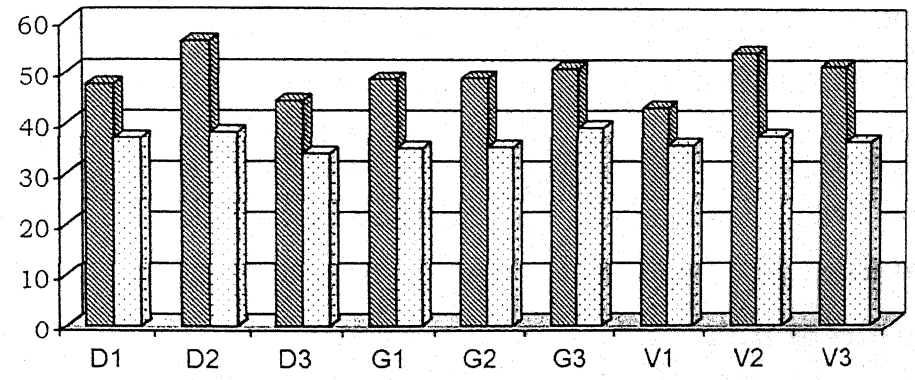
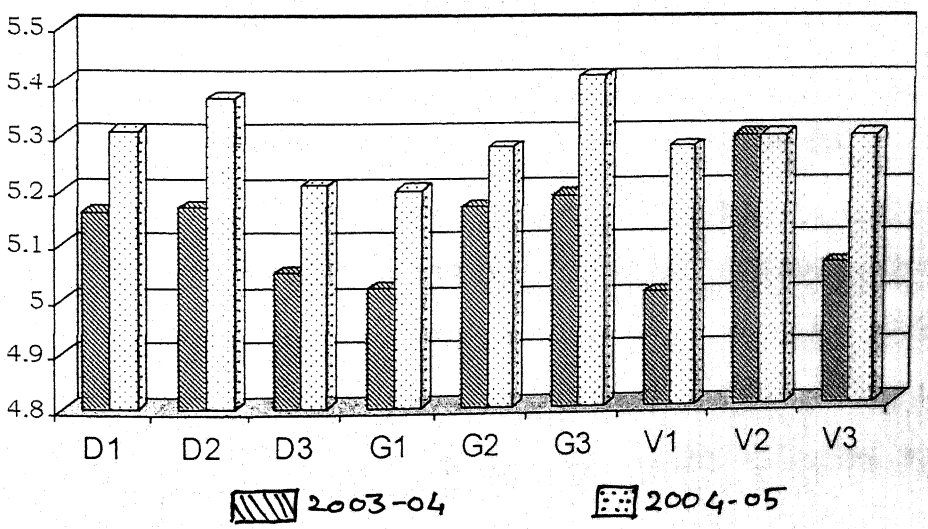


Fig. 14: Length of siliquae (cm) per plant as influenced by different treatments.



(60x15cm) was produced significantly more value in 2004-05 but in 2003-04, the difference between different geometries was non significant. The planting geometries such as G_2 (45x15cm) and G_1 (30x15cm) were also at par in this regard in 2004-05 year observation.

PERFORMANCE OF VARIETIES:

The Pusa bold (V_2) variety produced more number of siliquae/plant in both the years and mean value also over V_3 (Jagannath) and V_1 (Varuna) varieties respectively. The V_2 was significant in 2003-04 over others but at par with V_3 in 2004-05 years observation. The varieties such as V_3 and V_1 were non significant in this regard in both the years.

SIGNIFICANT INTERACTIONS:

The interaction effect in respect to number of siliquae/plant between different treatment combinations are given as follows.

Table($15a_1$):Number of siliquae/plant as affected by interaction DxV in both the years.

DxV	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
D_1	287.00	529.33	333.02	320.55	336.66	334.77
D_2	516.66	560.11	520.14	331.88	360.44	353.55
D_3	314.88	383.33	326.11	304.11	293.66	324.33
	SE ±17.80 CDat5% 39.83			SE± 15.99 CD at5% 32.15		

Reference in table ($15a_1$) showed that D_2V_2 interaction produced more number of siliquae/plant which was at par with D_1V_2 and significant over D_2V_3, D_2V_1, D_3V_2, D_1V_3 etc, respectively in 2003-04 year.

In 2004-05 year, the interaction D_2V_2 was non significant over D_2V_3, D_1V_2, D_1V_3, D_2V_1 and significant over other interactions.

Table-($15a_2$): Number of siliquae/plant as affected by interaction DxG and GxV in 2004-05 year.

D x V	2004-05			GxV	2004-05		
	G_1	G_2	G_3		V_1	V_2	V_3
D_1	316.66	321.00	363.88	G_1	310.55	306.11	324.88
D_2	333.77	338.88	368.33	G_2	313.66	314.44	342.77
D_3	312.00	307.88	298.66	G_3	332.33	370.22	347.00
SE ± 14.67		C.D.at 5% 31.85		SE ± 15.99		C.D. at 5%32.15	

It is showed in interaction D_2G_3 produced more number of siliquae/plant over others. The respective interactions was at par with D_1G_3 and D_2G_2 and significant over D_2G_1, D_1G_2, D_2G_1 etc, respectively.

In interaction GxV the number of siliquae/plant was maximum in G_3V_2 over others. The G_3V_2 was at par with G_3V_3, G_2V_3 and significant over G_3V_1, G_1V_3, G_2V_2, G_2V_1 etc respectively. The lowest value was in interaction G_1V_2 in this regard.

WEIGHT OF SILIQUAE/PLANT (g):

The data on weight of siliquae/plant (g) has been recorded and presented in table (15), fig. (13) and given in appendix (IX).

EFFECT OF SOWING DATES:

The data showed that D_2 (25 Oct.) sowing date increased maximum weight of siliquae/plant (g) in both the years over other dates of sowing. In 2003-04 year, The different sowing dates were significantly differed among each other while in 2004-05 it was significant only D_3 (10 Nov.) The sowing dates such as D_1 and D_3 were also significantly differed in this regard. The value in order to D_2 (25 Oct.), D_1 (10 Oct.) and D_3 (10 Nov.), respectively.

EFFECT OF PLANTING GEOMETRIES:

The weight of siliquae/plant (g) was significantly maximum in G_3 (60x15 cm) planting geometry in both the years. The plant spaces such as G_2 (45x15 cm) and G_1 (30x15) were at par in this regard in both the years of observations. The mean value in order to G_3, G_2 and G_1 planting geometries,respectively.

PERFORMANCE OF VARIETIES:

Table (15) and fig. (13) showed that V_2 (Pusa bold) variety produced maximum weight of siliquae/plant (g) in both the years. The respective variety was significantly superior over other varieties in 2003-04 while in 2004-05, it was at par with V_3 (Jagannath). The V_3 (Jagannath) was also significant in 1st year while in 2nd year, it was at par with V_1 (Varuna) variety.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations in weight of siliquae/plant (g) are as given follows:-

Table(15b$_1$):Weight of siliquae/plant (g) as affected by interaction DxV in both the years.

DxV	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
D_1	56.33	49.44	45.00	36.88	37.44	36.44
D_2	60.44	62.66	46.77	37.11	37.66	39.88
D_3	36.88	49.33	37.22	34.88	31.11	35.88
	SE ±1.50	CDat5% 3.43		SE± 1.58	CD at5% 3.82	

The presented table showed that maximum weight of siliquae per plant (g) was recorded in D_2V_2 which was at par with D_2V_1 and significant over D_1V_1, D_1V_2, D_3V_2 etc. respectively with the minimum value in D_3V_1 in 2003-04 year.

In 2004-05 year, the maximum value was recorded in D_2V_3 which was at par with D_2V_2, D_1V_2, D_2V_1, D_1V_1 and D_1V_3 and significant over other interactions.

Table-(15b$_2$): Weight of siliquae/plant (g) as affected by interaction DxGxV in both years.

2003-04

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	59.00	49.00	33.66	55.00	46.66	39.66	55.00	52.33	50.33
D_2	57.00	62.33	42.33	60.33	62.66	42.33	64.00	63.33	38.66
D_3	36.66	49.66	47.00	35.33	48.33	48.66	38.66	38.33	44.66
	SE ± 2.55			C.D. at 5% 5.13					

2004-05

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	34.66	33.33	35.66	27.33	30.33	36.33	42.66	29.66	35.66
D_2	31.33	33.66	34.33	40.66	48.66	42.00	39.33	30.66	33.00
D_3	35.00	35.33	41.33	40.33	44.33	41.33	35.33	33.66	37.00
SE ± 2.30				C.D. at 5% 4.63					

Table ($15b_2$) showed that in year 2003-04, the interaction $D_2G_3V_1$ increased maximum weight of siliquae/plant (g) over other interactions. The $D_2G_3V_1$ was at par with $D_2G_3V_2$, $D_1G_2V_2$, $D_2G_1V_2$, $D_2G_2V_1$ and significant over other interactions with the minimum value in $D_3G_2V_1$.

In year 2004-05, the significantly maximum weight of siliquae/plant (g) was recorded in $D_2G_2V_2$ except $D_3G_2V_2$ interaction and significant over other interactions with the lowest value was found in $D_2G_3V_2$ in this regard.

Table – ($15b_3$): Weight of siliquae/plant (g) as affected by interaction DxG and GxV in 2004-05.

D x G	2004-05			GxV	2004-05		
	G_1	G_2	G_3		V_1	V_2	V_3
D_1	36.00	34.55	31.33	G_1	39.11	31.33	35.22
D_2	34.33	33.11	43.77	G_2	36.11	41.44	39.88
D_3	35.33	37.22	42.00	G_3	33.36	34.11	37.11
SE ± 1.58		C.D.at 5% 3.82		SE ± 1.33		C.D. at 5% 2.67	

It is revealed in table ($15b_3$) that D_2G_3 interaction produced maximum weight of siliquae/plant (g) with at par to

D_3G_3 and significant over D_3G_2, D_1G_1, D_1G_3, D_3G_1 etc respectively.

In interaction GxV, the G_2V_2 recorded maximum weight of siliquae/plant (g) which was at par with G_2V_3 and G_1V_1 and significant over interactions such as G_3V_3,G_2V_1, G_1V_3, G_3V_2 etc, respectively.

LENGTH OF SILIQUA (Cm):

The data on length of siliqua (cm) have been recorded and presented in table (15) fig. (14) and are given in appendix (IX).

EFFECT OF SOWING DATES:

The length of siliqua (cm) was non significantly affected by different sowing dates in both the years. The value in order to D_2 (25 Oct.) D_1 (10 Oct.) and D_3 (10 Nov.),respectively.

EFFECT OF PLANTING GEOMETRIES:

The different planting geometries were also non significant among each other in both the years with more value in G_3 (60x15 cm), followed by G_2 (45x15 cm) and G_1 (30x15 cm), respectively in increasing length of siliqua (cm).

PERFORMANCE OF VARIETIES:

The variety V_2 (Pusa bold) increased with length of siliqua (cm) which was significantly more only in V_1 (Varuna) in 2003-04 but in 2004-05, the varieties were non significantly affected in this regard.

SIGNIFICANT INTERACTIONS:

Table(15c): Length of siliqua(cm) as affected by interaction DxG in year 2003-04.

D x G	G_1	G_2	G_3
D_1	4.99	5.45	5.05
D_2	5.15	4.79	5.51
D_3	4.90	5.31	4.93
SE ± 0.21		C.D. at 5% 0.44	

Reference to table (15c) showed that more length of siliqua (cm) was recorded in D_2G_3 interaction which was at par with D_1G_2, D_3G_2 and D_2G_1 and significant over D_1G_3, D_1G_1, D_3G_3, D_3G_1 etc respectively with the lowest value in D_2G_2 interaction.

NUMBER OF SEEDS/SILIQUA:

The data on number of seeds/siliqua have been recorded and presented in table (16), fig. (15) and are given in appendix (IX).

EFFECT OF SOWING DATES:

The sowing date D_2 (25 Oct.) increased significantly more number of seeds/siliqua over other dates in both the years. The D_1 (10 Oct.) sowing date was also significant over D_3 (10 Nov.) in 2003-04 year.

EFFECT OF PLANTING GEOMETRIES:

The different planting geometries were at par in 2003-04 and in 2004-05, G_3 (60x15 cm) was only significant over G_1 (30x15cm) in increasing number of seeds/siliqua.

PERFORMANCE OF VARIETIES:

The number of seeds/siliqua was recorded more in variety V_2 (Pusa bold) which was significant over V_1 (Varuna) in both the years. The value in order to V_2 (Pusa bold)V_3 (Jagannath) and V_1 (Varuna) varieties, respectively.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations in respect to number of seeds/siliqua are as follows.

Table(15d):Number of seeds/siliqua as affected by interaction DxG in both years.

DxG	2003-04			2004-05		
	G_1	G_2	G_3	G_1	G_2	G_3
D_1	12.90	12.53	11.68	11.93	12.27	11.83
D_2	13.26	13.72	13.82	12.51	13.33	12.76
D_3	11.52	10.53	10.57	11.48	11.88	10.75
	SE ±0.41 CDat5% 0.89			SE± 0.42 CD at5% 0.92		

In year 2003-04, the more number of seeds/siliqua was recorded in D_2G_3 interaction. The respective interaction was at par with D_2G_2 and D_2G_1 and significant over D_1G_1, D_1G_2, D_1G_3, D_3G_1 etc. respectively with the lowest value in D_3G_2.

In 2004-05, the interaction D_2G_2 increased more number of seeds/siliqua with non significant difference between D_2G_3 and

Table - 16 : Yield attributing characters as influenced by different treatments

Treatments	No. of seeds/siliqua			Weight of seeds/siliqua (mg)			Weight of seeds/plant (g)		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
Date of sowing									
D_1 (10 Oct.)	12.37	11.87	12.12	49.92	41.73	45.82	23.81	17.56	20.68
D_2 (25 Oct.)	13.60	12.68	13.14	53.96	46.62	50.29	28.22	18.75	23.48
D_3 (10 Nov.)	10.88	11.72	11.30	47.52	34.56	41.04	18.85	16.61	17.73
SE ±	0.19	0.20		0.73	0.79		0.11	0.18	
C.D. at 5%	0.52	0.56		2.02	2.20		0.31	0.50	
Planting geometry (Cm)									
G_1(30x15Cm)	12.03	11.79	11.91	49.49	40.65	45.07	22.01	16.99	19.50
G_2(45x15Cm)	12.26	11.98	12.12	50.84	40.88	45.86	23.42	17.01	20.21
G_3(60x15Cm)	12.56	12.50	12.53	51.06	41.39	46.22	25.45	18.92	22.18
SE ±	0.26	0.26	-	0.66	0.41		0.17	0.40	
C.D. at 5%	N.S.	0.52		1.33	N.S		0.35	0.81	
Varieties									
V_1 (Varuna)	11.92	11.55	11.73	44.98	39.46	42.22	23.30	17.11	20.20
V_2(Pusa bold)	12.57	12.43	12.50	56.36	42.05	49.05	23.99	18.27	21.13
V_3(Jagannath)	12.36	12.28	12.32	50.05	41.40	45.72	23.59	17.54	20.56
SE ±	0.26	0.26		0.66	0.41		0.17	0.40	
C.D. at 5%	0.53	0.52		1.33	0.82		0.35	0.81	
C.V. (%)	7.83	7.93		4.81	3.65		2.71	8.41	

N.S. = Non Significant

Fig.15: No. of seeds/siliqua as influenced by different treatments

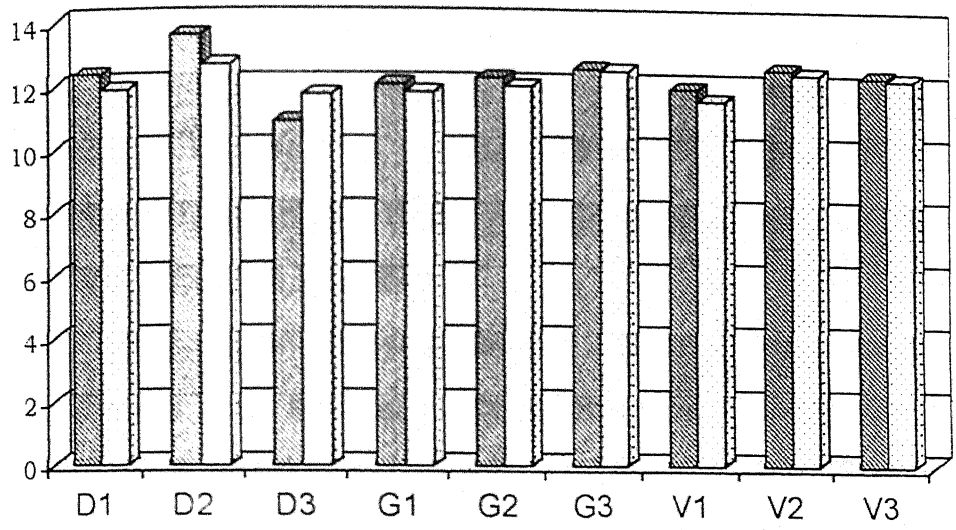
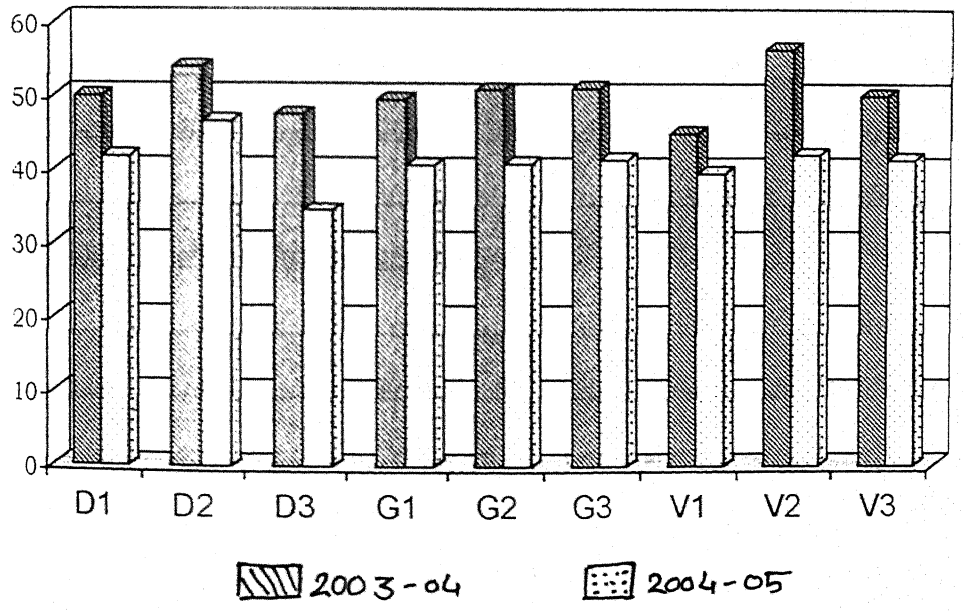


Fig.16: Weight of seeds/siliqua (mg) as influenced by different treatments



D_2G_1 and significant over others with the lowest value in D_3G_3 interaction.

WEIGHT OF SEEDS/SILIQUA(mg):

The data on weight of seeds/siliqua (mg) have been summarized and presented in table (16 to), fig. (16) and analysed data are given in appendix (IX).

EFFECT OF SOWING DATES:

Table (16) showed that different sowing dates were significantly differed among each other in both the years [illegible]

The significantly maximum value was recorded in D_2 (25 Oct.) followed by D_1 (10 Oct.) and D_3 (10 Nov.), respectively.

EFFECT OF PLANTING GEOMETRIES:

The weight of seeds/siliqua (mg) was found maximum in G_3 (60x15 cm) planting geometry followed by G_2 (45x15 cm) and G_1 (30x15 cm) respectively. The G_3 was significant over G_1 in 2004-05 while in 2003-04 year, the value was non significant.

PERFORMANCE OF VARIETIES:

The varieties were significantly differed among each other except V_2 (Pusa bold) and V_3 (Jagannath) in 2004-05. The mean value in order to V_2, V_3 and V_1 varieties, respectively.

WEIGHT OF SEEDS/PLANT (g)

The data on weight of seeds/plant (g) have been recorded and presented in table (16), fig. (17) and statistically analysed data are given in appendix (IX).

EFFECT OF SOWING DATES:

The data showed that different sowing dates were significantly differed in increasing weight of seeds/plant among each other in both the years. The D_2 (25 Oct.) sowing date was increased significantly maximum value over D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively. The mean value also recorded in same order.

EFFECT OF PLANTING GEOMETRIES:

The increasing planting geometries were also increased weight of seeds/plant in both the years. The G_3 (60x15 cm) planting geometry produced significantly maximum value in both years over G_2 (45x15 cm) and G_1 (30x15 cm) planting geometries respectively. The G_2 and G_1 were also significant in 2003-04 year observation. The mean value was also recorded in order to $G_3>G_2>G_1$.

PERFORMANCE OF VARIETIES:

The weight of seeds/plant was recorded maximum in V_2 (Pusa bold) variety in both the years. The respective variety was significant over V_1 (Varuna) in both the year but the difference between V_3 (Jagannath) and V_1 (Varuna) were non significant among each other in both the years of observations.

SIGNIFICANT INTERACTIONS:

The interaction effect in respect to weight of seeds/plant (g) between DxGxV was significant in year 2004-05.

Table(16a): Weight of seeds/plant (g) as affected by interaction DxGxV in 2004-05.

DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	14.79	17.51	14.96	16.62	15.55	17.72	16.80	17.97	17.57
D_2	15.64	19.96	19.36	18.51	15.57	17.55	21.16	21.46	19.57
D_3	17.52	15.86	17.54	16.54	19.99	14.86	16.46	20.59	18.75
SE ± 0.49					C.D. at 5% 1.41				

Reference to table (16a) showed that maximum weight of seeds/plant (g) was recorded in $D_2G_3V_2$ interaction with non significant difference to $D_2G_3V_1$ and $D_3G_3V_2$ and significant over $D_3G_2V_2$, $D_2G_1V_1$, $D_2G_3V_3$, $D_2G_1V_3$ etc, respectively with the minimum value in $D_3G_2V_3$.

YIELDS/UNIT AREA (q/ha):

The data on total produce (q/ha) seed yield (q/ha), stover yield (q/ha) and harvest index (%) was calculated from the experimental area on net plot basis and presented in table (17), depicted in fig. (18-21) and statistically analysed data are given in appendix (X).

TOTAL PRODUCE (q/ha):

The data on total produce (q/ha) have been recorded and presented in table (17), fig. (18) are given in appendix (X).

EFFECT OF SOWING DATES:

The presented table (17) revealed that different dates of sowing were significantly differed among each other in increasing total produce (q/ha) in both the years. The

Table - 17 : Yields/Unit area as influenced by different treatments.

Treatments	Total produce(q/ha)			Seed yield(q/ha)			Stover yield (q/ha)			Harvest index (q/ha)		
	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
Date of sowing												
D_1 (10 Oct.)	61.38	60.77	61.08	13.32	13.33	13.34	47.08	47.42	47.25	22.53	21.83	22.18
D_2 (25 Oct.)	65.34	66.12	65.73	14.44	14.63	14.53	49.62	52.08	50.85	22.29	22.40	22.35
D_3 (10 Nov.)	58.56	58.93	58.75	13.09	13.12	13.10	44.54	45.99	45.27	21.14	21.83	21.49
SE ±	0.46	0.41	-	0.09	0.45	0.17	0.78	0.43	-	0.64	0.36	
C.D. at 5%	1.28	1.15		0.25	1.25	0.49	2.17	1.19	-	N.S.	N.S.	
Planting geometry (Cm)												
G_1(30x15Cm)	63.11	62.71	62.91	13.58	13.72	13.60	47.68	49.71	48.70	22.67	23.03	22.85
G_2(45x15Cm)	63.39	64.22	63.81	14.05	14.24	14.14	49.22	51.17	50.20	23.12	22.84	22.98
G_3(60x15Cm)	58.78	58.89	58.84	13.23	13.11	12.13	44.34	44.62	44.48	20.17	20.19	20.18
SE ±	0.64	0.63	-	0.34	0.40	0.40	0.71	0.62	-	0.42	0.25	-
C.D. at 5%	1.30	1.26	-	0.67	0.81	0.81	1.42	1.24		0.85	0.49	
Varieties												
V_1 (Varuna)	52.74	52.81	52.78	12.02	12.14	12.09	39.12	40.49	39.81	18.97	17.94	18.46
V_2(Pusa bold)	68.61	68.04	68.33	15.39	15.50	15.44	54.42	55.20	54.81	24.02	25.45	24.74
V_3(Jagannath)	63.93	64.97	64.45	13.44	13.44	13.51	47.69	49.80	48.75	22.97	22.66	22.82
SE ±	0.64	0.63		0.34	0.40	0.40	0.71	0.62		0.42	0.25	
C.D. at 5%	1.30	1.26		0.67	0.81	0.81	1.42	1.24		0.85	0.49	
C.V. (%)	3.83	3.72		9.06	10.84		5.51	4.68		7.04	4.09	

Fig.17: Weight of seeds/plant (g) as influenced by different treatments.

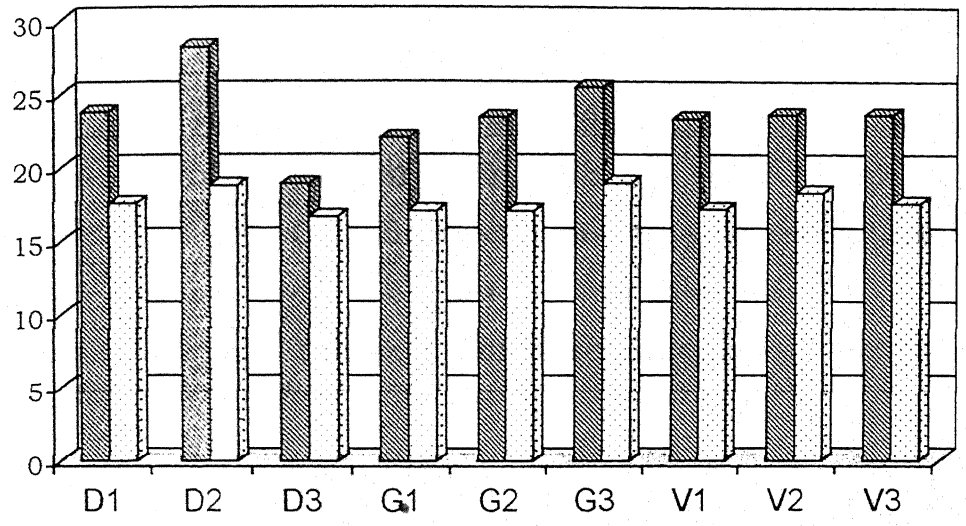
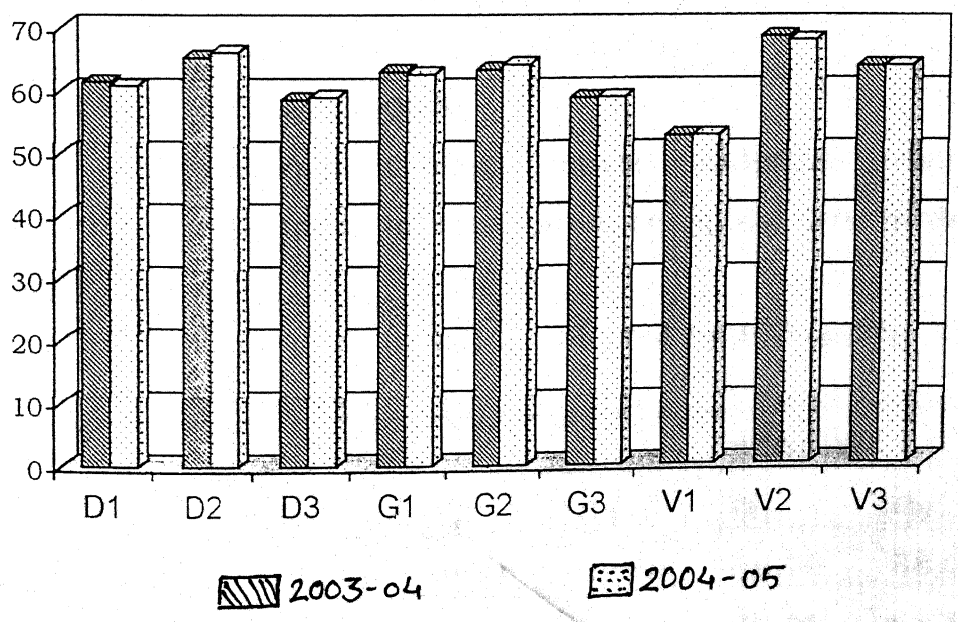


Fig.18: Total produce (q/ha) as influenced by different treatments.



significantly maximum value was recorded in D_2 (25 Oct.) sowing date followed by D_1 (10 Oct.) and D_3 (10 Nov.) respectively. The mean value was also maximum in D_2 (25 Oct.) sowing date.

EFFECT OF PLANTING GEOMETRIES:

The total biomass production (q/ha) was significantly differed in planting geometries in both the years except G_2 and G_1 in 2003-04. The G_2 (45x15 cm) planting geometry produced maximum value over G_1 (30x15 cm) and G_3 (60x15 cm), respectively in both the years of observations and mean value also.

PERFORMANCE OF VARIETIES:

The total produce (q/ha) was significantly increased by different varieties among each other in both the years. The variety V_2 (Pusa bold) produced significantly maximum value followed by V_3 (Jagannath) and V_1 (Varuna) varieties, respectively. The mean value was also found in same order.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations in respect to total produce (q/ha) are given as follows:-

Table(17a$_1$):Total produce (q/ha) as affected by Interaction (DxG) in both years.

DxG	2003-04			2004-05		
	G_1	G_2	G_3	G_1	G_2	G_3
D_1	62.49	61.79	59.84	60.60	66.70	58.01
D_2	67.06	68.99	59.94	66.85	70.05	61.44
D_3	59.77	59.35	58.77	60.67	58.89	57.20
	SE ± 1.02 CDat5% 2.21			SE± 0.97 CD at5% 2.10		

Reference to table indicated that D_2G_2 interaction produced significantly maximum total produce (q/ha) in both years over other interaction except D_2G_1 in 2003-04. The lowest value was found in D_3G3 interaction.

Table-($17a_2$): Total produce (q/ha) as affected by interaction DxV in both years.

DxG	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
D_1	50.93	69.67	63.52	51.11	67.59	63.61
D_2	58.43	71.89	65.67	57.50	72.81	68.03
D_3	48.84	64.26	62.57	49.79	65.72	63.26
	SE ±1.02 CDat5% 2.21			SE± 0.97 CD at5% 2.10		

It is showed in table ($17a_2$) that total produce (q/ha) was significantly maximum in D_2V_2 interaction in both years over other interactions. The significantly lowest value were recorded in D_3V_1 interaction.

Table – ($17a_3$): Total produce (q/ha) as affected by interaction GxV in both the years.

G x V	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
G_1	54.56	69.55	64.50	55.11	67.67	65.34
G_2	52.24	71.08	64.54	56.74	69.96	65.94
G_3	48.40	65.19	62.73	46.55	66.84	63.62
	SE ±1.11 CDat5% 2.24			SE± 1.08 CD at5% 2.18		

It is revealed in table (17a$_3$) that in both the years the interaction G_2V_2 produced significantly maximum total produced (q/ha) over other interactions with significantly lowest values in D_3V_1 interactions.

Table- (17a$_4$) : Total produce (q/ha) as affected by interaction DxGxV in both the years.

2003-04									
DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	52.63	72.21	63.63	47.92	73.67	63.80	53.23	63.15	63.14
D_2	62.18	72.15	66.85	63.16	75.98	67.85	49.96	67.53	62.33
D_3	51.92	64.28	63.13	52.60	63.61	61.86	42.02	64.88	62.73
SE ± 1.93				C.D. at 5% 3.88					

2004-05									
DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	50.94	68.04	62.83	54.61	71.15	65.33	47.79	63.57	62.68
D_2	60.97	72.60	68.98	62.62	76.82	70.73	48.93	71.02	64.37
D_3	53.41	64.39	64.22	61.91	61.76	42.94	64.85	63.81	62.73
SE ± 1.88				C.D. at 5% 3.78					

Reference to table (17a$_4$) showed in 2003-04 that total produce (q/ha) was recorded n $D_2G_2V_2$ interaction which was at par with $D_1G_2V_2$. $D_1G_1V_2$ and $D_2G_1V_2$ and significant over other interactions. The significantly lowest value was recorded with $D_3G_3V_1$ interaction.

The year 2004-05, the $D_2G_2V_2$ interaction produced significantly maximum total produce (q/ha) over other interactions such as $D_1G_2V_2$, $D_2G_3V_2$, $D_2G_2V_3$, $D_2G_1V_2$ etc, respectively. The interaction $D_3G_3V_1$ were recorded significantly minimum values in this regard.

SEED YIELD (q/ha):

The data on seed yield (q/ha) have been recorded and presented in table (17) fig. (19) and are given in appendix (X).

EFFECT OF SOWING DATES:

The data showed that D_2 (25 Oct.) sowing date produced significantly maximum seed yield (q/ha) over D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates respectively in both the years and pooled value also. The sowing dates such as D_1 and D_3 were at par in both the years in this regard.

EFFECT OF PLANTING GEOMETRIES:

The seed yield (q/ha) was maximum in G_2 (45x15cm) planting geometry followed by G_1 (30x15 cm) and G_3 (60x15 cm) respectively in both the years and pooled value also. Though the G_2 (45x15 cm) planting geometry produced maximum seed yield (q/ha) but it was at par with G_1 (30x15 cm) in both the years. The G_1 and G_3 planting geometries were also non significant in this regard.

PERFORMANCE OF VARIETIES:

Table (17) showed that variety V_2 (Pusa bold) recorded out yielded followed by V_3 (Jagannath) and V_1 (Varuna) varieties respectively in both the years. The different varieties were

significantly differed among each other in both the years in this regard. The pooled value was also significantly affected under different varieties in this regard.

STOVER YIELD (q/ha):

The data on stover yield (q/ha) have been recorded and presented in table (17), fig. (20) and are given in appendix (X).

EFFECT ON SOWING DATES:

The stover yield (q/ha) was significantly affected by different sowing dates among each others. The significantly maximum value was recorded in D_2 (25 Oct.) sowing date followed by D_1 (10 Oct.) and D_3 (10 Nov.), respectively in both the years.

EFFECT OF PLANTING GEOMETRIES:

The different planting geometries were significantly differed in increasing stover yield (q/ha). The significantly maximum value was recorded in G_2 (45x15 cm) followed by G_1 (30x15 cm) and G_3 (60x15 cm) planting geometries, respectively in both the years.

PERFORMANCE OF VARIETIES:

The different varieties were significantly differed in both the years in increasing stover yield (q/ha). The value in order to V_2 (Pusa bold) V_3 (Jagannath) and V_1 (Varuna) varieties, respectively.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations in respect to stover yield (q/ha) are as follows.

Fig.19: Seed yield (q ha) as influenced by different treatments.

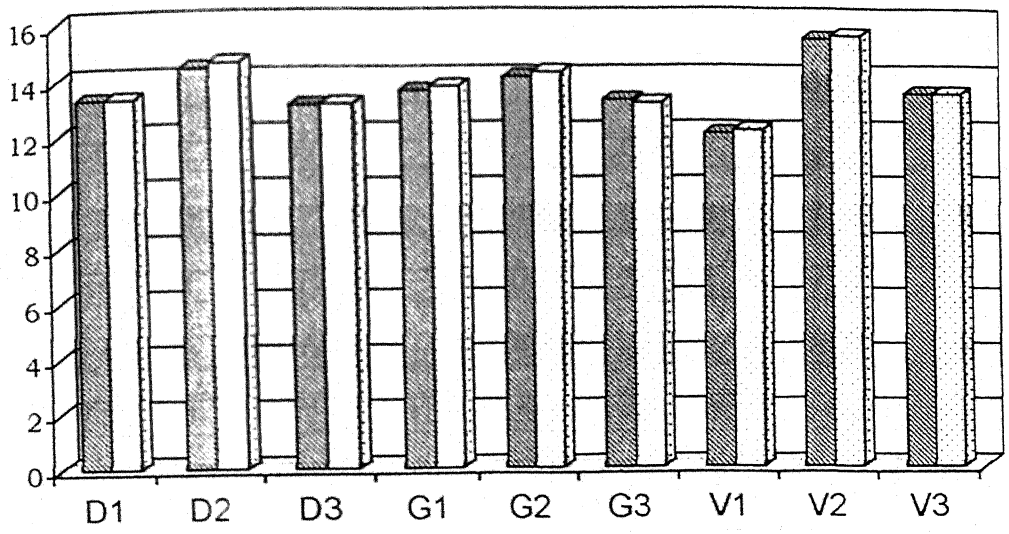


Fig.20: Stover yield (q ha) as influenced by different treatments.

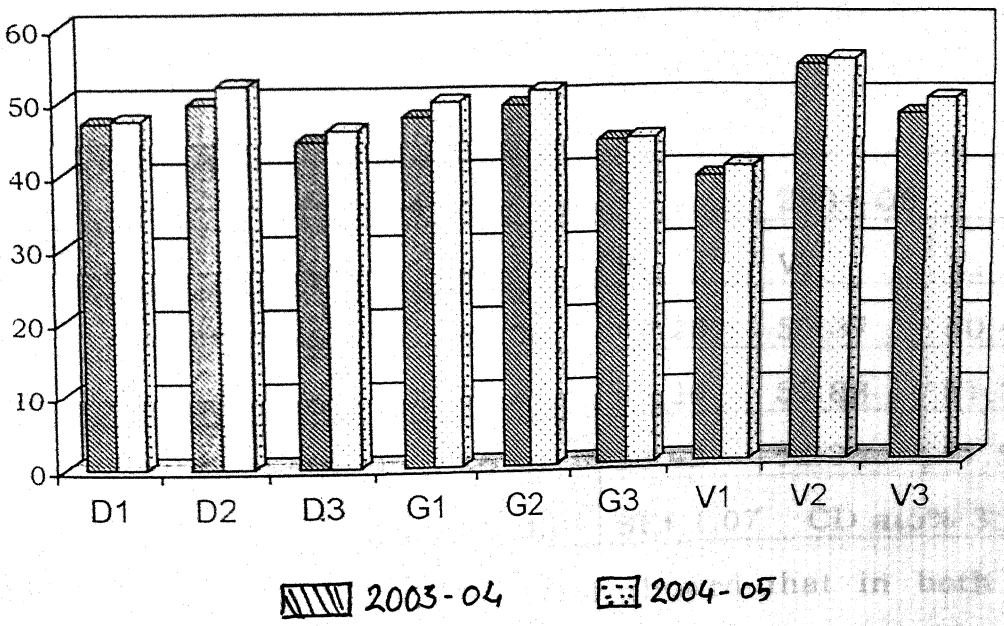


Table - ($17b_1$): Stover yield (q/ha) as affected by interaction DxG in both the years.

D x G	2003-04			2004-05		
	G_1	G_2	G_3	G_1	G_2	G_3
D_1	49.15	47.59	44.48	50.43	47.61	44.22
D_2	49.61	53.16	46.07	53.14	57.60	45.48
D_3	44.26	46.91	42.45	45.55	48.27	44.15
	SE ±1.26 CDat5% 2.91			SE± 0.97 CD at5% 2.10		

The presented table ($17b_1$) indicated that significantly maximum stover yield (q/ha) was recorded in D_2G_2 interaction in both the years over D_2G_1, D_1G_1 etc, respectively. The lowest value was recorded with D_3G_3 interaction.

Table – ($17b_2$): Stover yield (q/ha) as affected by interaction GxV in both the years.

G x V	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
G_1	40.23	56.18	48.06	42.28	56.37	50.47
G_2	42.85	56.41	48.41	45.26	56.88	51.34
G_3	34.28	50.65	46.80	33.92	52.35	47.58
	SE ±1.22 CDat5% 2.45			SE± 1.07 CD at5% 3.72		

Reference to table ($17b_2$) showed that in both the years, the interaction G_2V_2 produced maximum stover yield (q/ha) which was at par with G_1V_2 and significant over G_3V_2,

G_1V_3 etc. respectively. The significant lowest values were recorded in G_3V_1 interactions.

Table – ($17b_3$): Stover yield (q/ha) as affected by interaction DxGxV in both the years.

2003-04									
DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	36.04	58.94	47.78	42.00	58.37	47.08	37.91	47.95	47.58
D_2	48.33	59.22	51.94	43.16	60.63	45.04	35.80	52.07	49.93
D_3	44.17	51.07	45.50	35.55	49.55	47.68	29.13	51.54	46.68
SE ± 2.11				C.D. at 5% 4.25					

2004-05									
DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	36.44	58.95	47.44	42.40	59.45	49.44	36.65	49.33	46.68
D_2	55.89	58.51	58.42	45.79	60.30	53.34	34.92	54.28	47.53
D_3	43.46	53.19	48.16	38.67	49.35	48.62	30.50	53.43	48.54
SE ± 1.85				C.D. at 5% 3.72					

In the year 2003-04 the maximum stover yield (q/ha) was recorded in $D_2G_2V_2$ interaction (Table $17b_3$). The respective interaction was at par with $D_2G_1V_2$ and $D_1G_2V_2$ and significant over others with the significant lowest value in $D_3G_3V_1$ interaction.

The presented table ($17b_3$) in the year 2004-05 showed that interaction $D_2G_2V_2$ produced maximum stover yield

(q/ha) which was at par with $D_1G_2V_2$, $D_1G_1V_2$ and $D_2G_1V_2$ and significantly over other interactions with significantly lowest value in $D_3G_3V_1$.

HARVEST INDEX (%):

The data on harvest index (%) have been computed an presented in table (17), fig. (21) and are given in appendix (X).

EFFECT OF SOWING DATES:

The harvest index was non significantly affected by sowing dates in both the years. The mean value in order to D_2 (25 Oct.), D_3 (10 Nov.) and D_1 (10 Oct.),respectively.

EFFECT OF PLANTING GEOMETRIES:

The harvest index was recorded more in G_2 (45x15 cm) in 2003-04 and G_1 (30x15 cm) in 2004-05 year. The both planting geometries were at par among each others in both the years and these values were significantly superior over G_1 (30x15 cm) planting geometries in both the years.

PERFORMANCE OF VARIETIES:

The varieties were significantly differed among each other in respect to harvest index (%) in both the years. The significantly more value was computed in V_2 (Pusa bold) followed by V_3 (Jagannath) and V_1 (Varuna) varieties,respectively.

SIGNIFICANT INTERACTIONS:

The interaction effect between different treatment combinations in respect to harvest index are as follows.

Table – (17c$_1$): Harvest index (%) as affected by interaction DxG in both the years.

D x G	2003-04			2004-05		
	G_1	G_2	G_3	G_1	G_2	G_3
D_1	20.69	20.37	22.34	21.20	20.86	23.42
D_2	19.17	25.14	22.56	19.26	24.87	23.06
D_3	20.63	23.84	23.10	20.09	22.77	22.61
	SE ±0.87 CDat5% 2.11			SE± 0.49 CD at5% 1.19		

Reference to table (17C$_1$) indicated that significantly more harvest index was recorded in D_2G_2 interaction in both the years except D_3G_2 in 2003-04 year. Over other interactions. The lowest value in both the years was recorded in D_3G_1 interaction.

Table – (17c$_2$) : Harvest index as affected by interaction DxV in both the years.

D x V	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
D_1	20.69	20.80	21.92	17.84	25.15	22.49
D_2	17.36	29.92	23.59	13.34	26.14	23.71
D_3	18.84	25.32	23.40	18.64	25.06	21.78

It is showed in table (17C$_2$) that in both the years more harvest index was recorded in D_2V_2 interaction over others. The respective interaction was significantly superior in 2003-04

year but in 2004-05 it was at par with D_1V_2 and D_3V_2 and also significant over other interactions.

Table – ($17c_3$) : Harvest index as affected by interaction GxV in both the years.

G x V	2003-04			2004-05		
	V_1	V_2	V_3	V_1	V_2	V_3
G_1	17.39	26.25	24.36	17.96	26.68	24.45
G_2	19.57	26.52	23.26	18.58	26.99	23.13
G_3	19.93	19.27	21.29	17.27	22.88	20.40
	SE ±0.73	CDat5% 1.46		SE± 0.42	CD at5% 0.85	

Reference to table ($17C_3$) indicated that G_2V_2 interaction increased more harvest index over other interactions in both the years. The G_2V_2 was at par with G_1V_2 and significant over G_1V_3, G_2V_3 etc interactions in both the years.

Table – ($17c_4$) : Harvest index as affected by interaction DxGxV in both the years.

2003-04									
DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	23.72	14.59	23.77	18.00	23.54	19.56	20.35	24.26	24.41
D_2	18.23	19.68	19.59	18.53	30.76	26.13	15.31	27.33	25.05
D_3	17.85	23.53	20.50	22.18	25.27	24.08	16.50	27.17	25.63
SE ± 1.26				C.D. at 5% 2.54					

2004-05									
DxGxV	G_1V_1	G_1V_2	G_1V_3	G_2V_1	G_2V_2	G_2V_3	G_3V_1	G_3V_2	G_3V_3
D_1	15.52	25.55	22.52	16.49	24.55	21.56	21.52	25.34	23.39
D_2	18.82	19.62	19.33	18.81	29.49	26.31	14.39	29.30	25.49
D_3	17.49	23.44	19.36	20.46	26.36	21.52	17.97	25.39	24.46
SE ± 0.73				C.D. at 5% 1.47					

In year 2003-04, the significantly more harvest index was recorded in $D_2G_2V_2$ interaction over $D_2G_3V_2$, $D_3G_3V_1$. $D_2G_2V_3$, $D_3G_3V_3$ etc, respectively. The lowest value was recorded in $D_3G_1V_1$ in this regard.

It is revealed in table ($17C_4$) in year 2004-05 that interaction $D_2G_2V_2$ was also more with at par over $D_2G_3V_2$ and significant over $D_3G_2V_2$, $D_3G_2V_2$, $D_2G_2V_3$, $D_2G_3V_3$ etc, respectively with the minimum value in $D_3G_1V_1$.

QUALITY:

The quality parameters of the mustard such as weight of 1000 seeds (g), percent protein content and percent oil content were studied in both the years and presented in table (18) and illustrated geographically in fig. (22-24). The statistically analysed data are given in appendix (XI).

WEIGHT OF 1000 SEEDS (g):

The data on weight of 1000 seeds(g) have been recorded and presented in table (18), fig. (22) and are given in appendix (XI).

EFFECT OF SOWING DATES:

The 1000 seeds weight(G0 was increased non significantly by different dates of sowing with maximum value in D_2 (25 Oct.) in both years.

Table: - 18 : 1000 Seed weight (g), Percent Oil content and Percent protein content as influenced by different treatments.

Treatments	Weight of 1000 seeds (g)			Oil content (%)			Protein content (%)		
Date of sowing	2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
D_1 (10 Oct.)	5.83	5.97	5.90	36.95	37.99	37.47	19.84	19.28	19.56
D_2 (25 Oct.)	5.87	6.02	5.95	41.69	41.82	41.76	21.58	21.61	21.601
D_3 (10 Nov.)	5.80	5.83	5.81	34.22	33.67	33.95	18.45	18.19	18.32
SE ±	0.06	0.24		0.30	0.12		0.11	0.16	
C.D. at 5%	N.S.	N.S.		0.84	0.34		0.30	0.45	
Planting geometry (Cm)									
G_1 (30x15Cm)	5.65	5.92	5.78	37.15	36.77	36.96	19.38	19.41	19.40
G_2 (45x15Cm)	5.83	5.92	5.87	37.40	37.69	37.55	20.02	19.73	19.87
G_3 (60x15Cm)	6.01	5.97	5.99	38.32	39.03	38.68	20.47	19.95	20.21
SE ±	0.09	0.12		0.30	0.22		0.12	0.22	
C.D. at 5%	0.19	N.S.		0.61	0.43		0.24	0.44	
Varieties									
V_1 (Varuna)	5.59	5.89	5.74	35.86	37.33	36.60	19.68	19.49	19.58
V_2 (Pusa bold)	6.33	5.97	6.15	39.23	38.41	38.82	20.17	19.91	20.04
V_3 (Jagannath)	5.58	5.95	5.77	37.78	37.74	37.76	20.02	19.68	19.85
SE ±	0.09	0.12		0.30	0.22		0.12	0.22	
C.D. at 5%	0.19	N.S.		0.61	0.43		0.24	0.44	
C.V. (%)									

N.S. = Nonsignificant

Fig.21: Harvest index (%)as influenced by different treatments.

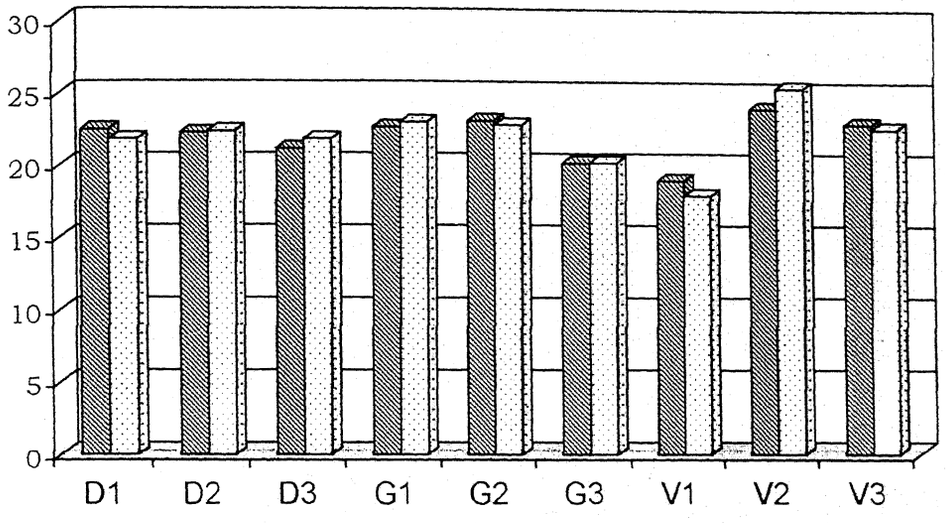


Fig.22: Test weight (1000 seed weight in g) as influenced by different treatments.

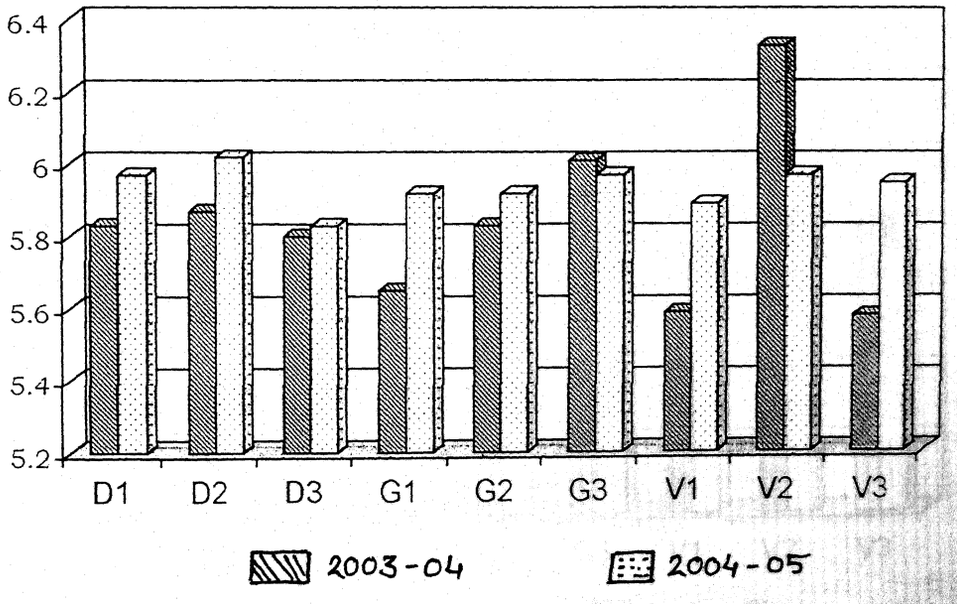


Fig.23: Oil content (%) as influenced by different treatments.

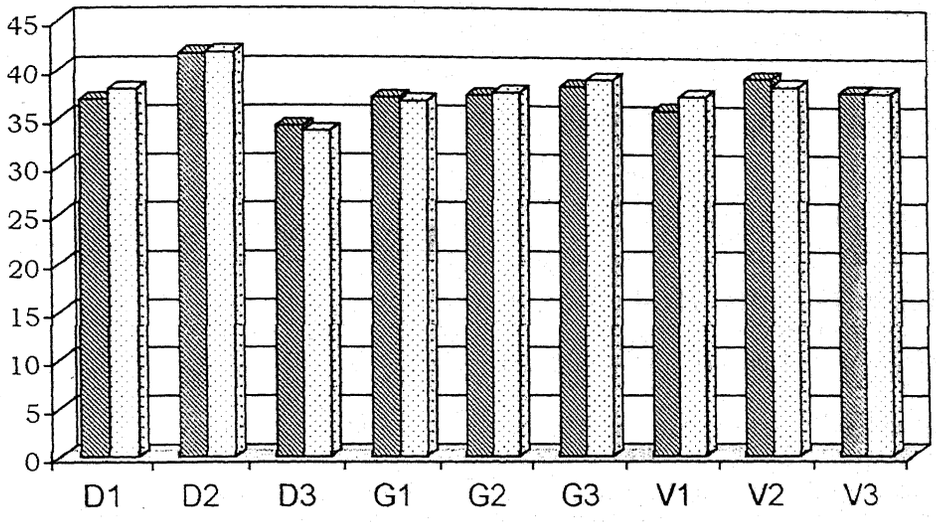
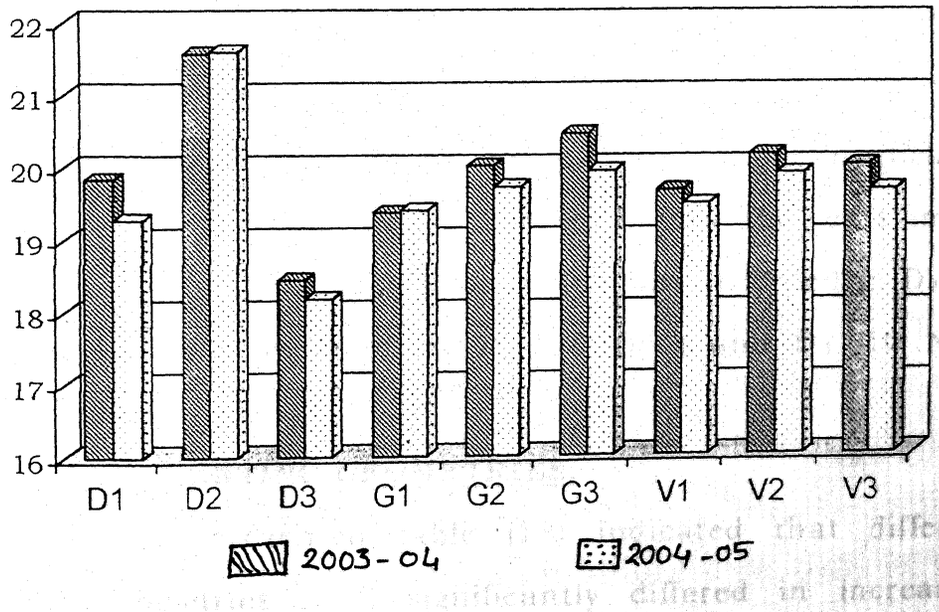


Fig. 24: Protein content (%) as influenced by different treatments.



EFFECT OF PLANTING GEOMETRIES:

The weight of 1000 seeds (g) was non significantly affected by planting geometries in 2004-05 year. In 2003-04, the G_3 (60x15 cm) was significant over G_1 (30x15 cm) while G_2 (45x15 cm) and G_1 (30x15 cm) were also non significant in this regard.

PERFORMANCE OF VARIETIES:

The varieties were non significantly affected weight of 1000 seeds (g) in 2004-05 year. In 2003-04, the variety V_2 (Pusa bold) was significantly superior over other varieties. The varieties such as V_1 (Varuna) and V_3 (Jagannath) were also non significantly affected in weight of 1000 seeds (g) increasement.

PERCENT OIL CONTENT:

The data on percent oil content have been recorded and presented in table (18), fig. (23) and are given in appendix (XI).

EFFECT OF SOWING DATES:

Data showed that sowing dates significantly affected in increasing percent oil content in both the years among each other. The significantly more value was recorded in D_2 (25 Oct.) sowing date followed by D_1 (10 Oct.) and D_3 (10 Nov.), respectively.

EFFECT OF PLANTING GEOMETRIES:

The presented table (18) indicated that different planting geometries significantly differed in increasing percentage oil content in both the years except G_2 (45x15 cm)

and G_1 (30x15 cm) in 2003-04 year. The value in order to G_3, G_2 and G_1 planting geometries, respectively.

PERFORMANCE OF VARIETIES:

The percent oil content was increased significantly in different varieties except V_3 (Jagannath) and V_1 (Varuna) in 2004-05 year. The variety V_2 (Pusa bold) produced significantly maximum percent oil content over V_3 (Jagannath) and V_1 (Varuna) varieties, respectively.

SIGNIFICANT INTERACTIONS:

The interaction effect in respect to percent oil content between different treatment combinations are as follows.

Table (18a) : Percent oil content as affected by interaction DxG and DxV in 2003-04.

DxG & DxV	2003-04			2003-04		
	G_1	G_2	G_3	V_1	V_2	V_3
D_1	37.57	36.17	37.10	32.90	40.58	37.36
D_2	40.64	41.66	42.76	40.89	42.39	41.78
D_3	33.22	34.35	35.08	33.79	34.70	34.17
	SE ± 0.52 C.D.at 5% 1.19			SE ±0.52 C.D.at5% 1.19		

Reference to table (18a) interaction DxG showed that D_2G_3 interaction produced maximum percent oil content which was at par with D_2G_2 and significant over D_2G_1, D_1G_1, D_1G_3, D_1G_2 etc respectively. The lowest value was recorded in D_3G_1 in this regard.

In interaction DxV, showed that D_2V_2 increased maximum percent protein content and significant except D_2V_3 over D_2V_1, D_1V_2, D_1V_3 etc, respectively with the minimum value in D_1V_1 interaction.

PERCENT PROTEIN CONTENT:

The data on percent protein content have been summarized and presented in table (18), fig. (24) and are given in appendix (XI).

EFFECT OF SOWING DATES:

Data showed that percent protein content in both the years was differed significantly among dates of sowing. The D_2 (25 Oct.) sowing date increased significantly maximum value over D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively The mean value was also in same order in this regard.

EFFECT OF PLANTING GEOMETRIES:

The maximum percent protein content was found in G_3 (60x15 cm) planting geometry in both the years. In 2003-04 year the value was differed significantly among each other while in 2004-05. it was at par with G_3, G_2 and G_2, G_1 planting geometries in this regard.

PERFORMANCE OF VARIETIES:

The V_2 (Pusa bold) variety produced maximum percent protein content followed by V_3 (Jagannath) and V_1 (Varuna) varieties, respectively. The varieties such as V_3 and V_2 were at par in both the years. In 2003-04 year, the variety V_3 (Jagannath) was significant over V_1 (Varuna) in this regard.

SIGNIFICANT INTERACTIONS:

Table – ($18a_1$) : Percent protein content as affected by interaction DxG and DxV in 2004-05 year.

DxG & DxV	2004-05			2004-05		
	G_1	G_2	G_3	V_1	V_2	V_3
D_1	19.27	19.86	18.70	19.60	18.29	19.95
D_2	21.37	21.66	21.80	21.48	21.68	21.67
D_3	17.56	18.32	18.66	17.95	18.48	18.12
	SE ± 0.35 C.D.at 5% 0.76			SE ± 0.35 C.D.at5% 0.76		

In interaction DxG the maximum percent protein was found in D_2G_2 interaction with non significant difference to D_2G_1 and D_2G_1 and significant over D_1G_2, D_1G_1, D_1G_3, D_3G_3 etc. with the lowest value in D_3V_1.

It is showed in interaction DxV table ($18b_1$) that D_2V_2 increased maximum percent protein content which was also at par D_2V_3 and D_2V_1 and significant over D_1V_3, D_1V_1, D_1V_2, D_3V_2 etc. respectively with the minimum value in D_3V_1 interaction.

Chapter - V
ECONOMICS

CHAPTER – V

ECONOMICS

It is interesting to compare the performance of various treatment combinations in terms of economics which is important to the farmers. The farmers have very limited resources in the form of facilities such as fertilizer, irrigation and they are not such a position to purchase seeds of varieties year after year. It is therefore, necessary to workout the most economic and suitable variety for a particular tract and their economic inputs for obtaining the maximum yield as well as net profit for their use.

Keeping these points in view, the economics of various treatments of the trial was calculated in this study. The detailed common cost of cultivation has been given in appendix (XIIa & b) and the statement of total input and net profit (Rs/ha) are given in appendix (XIIc) under different treatments combinations. The summary of input and output are presented in table (19).

TOTAL COST OF CULTIVATION (Rs./ha)

The data on total cost of cultivation (Rs/ha) have been computed and presented in table(19) and are given in appendix XII(a).

EFFECT OF SOWING DATES:

The data presented in table (19) indicated that total cost of cultivation (Rs. 10775.44 and Rs. 10816.76/ha) was

Table-19: Total cost of cultivation (Rs./ha), Total Gross return (Rs./ha), Total Net Return(Rs./ha) and B/C ratio as influenced by different treatments.

Treatments	Total cost of cultivation (Rs/ha)			Total Gross return (Rs/ha)			Total Net return (Rs/ha)			B/C Ratio		
	2003-04	2004-05	mean	2003-04	2004-05	mean	2003-04	2004-05	mean	2003-04	2004-05	mean
SOWING DATES												
D_1 (10 Oct.)	10646.57	10660.85	10653.70	23509.80	23629.41	23519.60	12863.23	12868.88	12865.90	1.21	1.21	1.21
D_2 (25 Oct.)	10775.44	10816.75	10796.10	25488.56	25810.18	25649.37	14713.12	14993.42	14853.27	1.32	1.38	1.38
D_3 (10 Nov.)	10618.71	10631.02	10624.86	23108.25	23024.04	23101.14	12489.54	12476.02	12476.28	1.18	1.17	1.17
PLANTING GEOMETRIES												
G_1 (30x15 cm)	10671.37	10703.29	10687.33	23963.33	24151.04	24057.18	13291.96	13447.75	13369.86	1.25	1.26	1.25
G_2 (45x15 cm)	10733.37	10770.37	10772.03	24794.32	25129.67	24961.99	14060.63	14359.30	14209.97	1.31	1.33	1.32
G_3 (60x15 cm)	10635.66	10635.09	10635.38	23348.98	23152.88	23250.93	12713.32	12517.79	12615.56	1.20	1.18	1.19
VARIETIES												
V_1 (Varuna)	10491.09	10512.27	10501.68	21217.26	21912.05	21564.65	10726.17	11399.99	11063.08	1.02	1.08	1.05
V_2 (Pusa bold)	10888.89	10923.22	10906.05	27161.38	27367.30	27264.34	16272.49	16444.08	16358.29	1.49	1.50	1.49
V_3 (Jagannath)	10660.73	10673.11	10666.92	23723.56	23709.83	23716.69	13062.83	13036.72	13049.78	1.23	1.22	1.22

calculated in D_2 (25 Oct.) sowing date in both the years. Followed by D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates,respectively.

EFFECT OF PLANTING GEOMETRIES:

The planting geometry G_2 (45x15 cm) computed maximum total cost of cultivation (Rs.10773.69 and Rs.10770.37 /ha) in both the years as compared to G_2 (30x15 cm) and G_3 (60x15 cm) planting geometries,respectively.

PERFORMANCE OF VARIETIES:

Table (19) showed that variety V_2 (Pusa bold) expended maximum total cost of cultivators Rs. 10888.89 and Rs. 10923.22/ha in individual two years followed by remaining varieties such as V_3 (Jagannath) and V_1 (Varuna),respectively.

TOTAL GROSS RETURN (Rs/ha):

The data on total gross return (Rs/ha) have been calculated and presented in table (19) and are given in appendix XII (c).

EFFECT OF SOWING DATES:

Table (19) showed that total gross return (Rs. 25649.37/ha) was accured in D_2 (25 Oct.) sowing dates followed by other sowing dates. The respective date of sowing was received Rs. 2129.77 and Rs. 2548.23/ha as additional value over D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively is due to maximum values in D_2 sowing date in both the years.

EFFECT OF PLANTING GEOMETRIES:

The G_2 (45x15 cm) planting geometry received maximum total gross returns in both the years and mean value

also. The G_2 planting space on mean value base (Rs.24961.99/ha) accured Rs. 904.81 and Rs. 1711.06/ha as extra total gross return (Rs/ha) over G_1 (30x15 cm) and G_3 (60x15 cm) planting geometries,respectively.

PERFORMANCE OF VARIETIES:

The presented table (19) indicate maximum total gross return (Rs/ha) in both the years was computed in V_2 (Pusa bold) varuiety over other varieties. On mean value basis (Rs.27264.34/ha) the V_2 variety received as a additional values as Rs. 3547.65 and Rs. 5699.69/ha over the varieties V_3 (Jagannath) and V_1 (Varuna),respectively.

TOTAL NET RETURN(Rs/ha)

The data on total net return (Rs/ha) have been calculated and presented in table (19) and are given in appendix XII (C).

EFFECT OF SOWING DATES:

The total net return (Rs/ha) was maximum in sowing date D_2 (25 Oct.) in both the years. The D_2 sowing date on mean value base, was gained Rs. 1987.37 and Rs. 2376.99/ha as additional value over D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively.

EFFECT OF PLANTING GEOMETRIES:

In planting geometries, the G_2 (45x15 cm) was accured maximum total net return (Rs/ha) in both the years over others. The mean value of Rs. 840.11 and Rs. 1594.41/ha was

additional in G_2 (45x15 cm) followed by G_1 (30x15 cm) and G_3 (60x15 cm) planting geometries,respectively.

PERFORMANCE OF VARIETIES:

The maximum total net return (Rs/ha) in both the years was gained in variety V_2 (Pusa bold) over other varieties. On the mean value basis it received Rs. 3308.51 and Rs. 5295.21/ha as extra value over V_3 (Jagannath) and V_1 (Varuna) varieties,respectively.

BEBEFIT/COST RATIO:

The data on B/C ratio was calculated and presented in table (19) and are given in appendix XII (C).

EFFECT OF SOWING DATES:

The benefit/cost ratio was also found more in D_2 (25 Oct.) sowing time in both years and mean value also over D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates,respectively.

EFFECT OF PLANTING GEOMETRIES:

Table (19) revealed that G_2 (45x15 cm) planting geometry was recorded more benefit/cost ratio in both years and mean value over G_1 (30x15 cm) and G_3 (60x15 cm),respectively.

PERFORMANCE OF VARIETIES:

The presented data showed that in both years, the more benefit/cost ratio was received in V_2 (Pusa bold) variety followed by V_3 (Jagannath) and V_1 (Varuna) varieties,respectively.

Chapter - VI
DISCUSSION

CHAPTER – VI

DISCUSSION

The result of the investigation entitled "Effect of sowing dates, planting geometry and varieties on growth, yield and quality of mustard (Brassica juncea coss). under irrigated conditions of Bundelkhand in U.P. was embodied in the previous chapter. An attempt has been made to interprete and explain these findings with a view to under stand the 'Cause' and Effect' relationship among growth, yield, quality and economics of the crop. The experimental findings has been discussed under the following heads:-

WEATHER EFFECT:

Geographically the experimental station is located in southern U.P. in Bundelkhand region. The experimental crop received 8.0 and 6.6 mm rains during 2003-04 and 2004-05 respectively. It first year rains occurred twice in January and March in 1st and 2nd years. Thus, winter rains during second year benefited crop more than first year. The minimum temperature during crop period gone down to 3.9 and 5.2°C while maximum temperature rise 37.5°C and 35.03°C during first and second year respectively. The evaporation rate was recorded between 1.1 to and 1.8 to 6.2mm/day during both the years. The minimum during January was comparatively lesser in first than the second year of study. It might have affected up to some extent the growth of experimental crop in that particular period

which was exhibited in yield and general performance of crop in the year. Otherwise the experimental crop availed similar atmosphere during two years of experimentation.

EFFECT OF SOWING DATES:

The optimum time of sowing for a particular crop and their variety under agro-climatic condition on a tract have great importance than other agro techniques and inputs under available resources for producing maximum and economic yield of the crop.

EFFECT ON GROWTH PHENOLOGY:

The growth of the crop is determined by height of plant, fresh and dry weight/plant and their shoots per plant. The examination of the table (7 to 14) that all the growth characters such as height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant and number of primary, secondary and tertiary branches per plant were recorded significantly maximum in sowing date 25 October (D_2) followed by 10 October (D_1) and 10 November sowing dates, respectively. The days of 50% flowering and 50% maturity were also more in 25 October (D_2) sowing date. The more growth in 25 October (D_2) sowing date was found due to suitable growth period and optimum agro climatic conditions for their growth and development of plant. Yadav et al. (1996), Singh et al. (2001) and Panda (2004) also reported that 2nd fortnight of October was the optimum time for sowing mustard crop. The early sowing in this tract, due to rise temperature was adversely affected to germination and

growth of the mustard crop. In delay sowing after 3rd and 4th weeks of October. The growth and development of plant was reduced due to short growing period and sudden dropping temperature during the grant growth period. The results were conformity with the findings of Bisnoi and Singh (1979), Narang and Singh (1987), Jadav and Singh (1992) and Yadav et al. (1996).

EFFECT ON YIELD ATTRIBUTES AND YIELD:

Reference to table (15 to 16) that yield contributing characters such as number of siliquae/plant, weight of siliquae/plant, length of siliquae, number of seeds/siliqua, weight of seeds/siliquae and weight of seeds/plant were found maximum in 25 October (D_2) sowing date followed by 10 October (D_1) and 10 November (D_3) sowing dates, respectively. It is due to optimum sowing time and favourable climatic conditions for mustard crop. Patel et al. (1980), Jadav and Singh (1992), Yadav et al. (1994) and Panda et al. (2004) were also reported same results.

In respect to seed yield in q/ha, the seed weight/plant and their attributes are responsible for it. The examination of results given in table (17) showed that 25 October (D_2) sowing date produced significantly maximum seed yield (q/ha) in both the years and pooled value recorded 8.19 and 9.84 percent more seed yield (q/ha) over 10 October (D_1) and 10 November (D_3) sowing dates, respectively. The same trend was also observed in yield attributes as number and weight of siliquae/plant, length of silquae, number of seeds and weight of seeds/siliqua and weight

of seeds/plant. The above all yield contributing characters were enhanced and pushed for increasing seed yield in q/ha in 25 October (D_2) sowing date. The seed yield in respective sowing date was maximum due to optimum time for growth period better climatic conditions during flowering and more fruiting of plants. The results were conformity with the findings of Patel et al. (1980), Singh (1985), Jadav and Singh (1992), Yadav et al. (1996), Batter and Aulakh (1999), Singh et al. (2001) and Panda et al. (2004).

EFFECT OF SOWING DATES ON GROWTH YIELD ATTRIBUTES AND YIELD:

The data presented in table 7 to 14 clearly indicate that all round improvement on growth characters such as height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant, number of primary, secondary and tertiary branches/plant were found significantly maximum in sowing date 25 October (D_2). The days to 50%, flowering and 50% maturity were also significantly more in respective date of sowing in both the years and mean value also. The more number of leaves/plant and leaf area increased more photosynthesis and accumulation of accimilates for longer period improved the growth development and dry matter production /plant in respective sowing date (25 October) due to optimum sowing time and favourable climatic conditions especially temperature. In respect to yield attributes (Table 15 to 16), such as number and weight of siliquae/plant, length of siliquae, number of seeds and weight of

seeds/siliquae, weight of seeds/plant and weight of 1000 seeds were also found maximum in 25 October (D_2) sowing date over other dates of sowing in both the years. The more growth and development especially dry matter accumulation/plant and number of branches/plant were push to increase yield attributes and seed weight/plant, This might be due to more favourable climatic conditions in respect to growth, development and transformation of food materials for longer period to reproductive parts, hence increase to growth parameters and yield attributes. The above all growth, development and yield contributing characters were positively pushed and enhanced to increase biomass production and seed yield in q/ha in 25 October (D_2) sowing date over early and late dates of sowing table (17). The results are similar to those obtained by Patel et al. (1980), Singh (1985), Yadav and Singh (1992), Yadav et al. (1996), Singh et al. (2001) and Panda et al. (2004).

EFFECT OF SEED QUALITY:

The presented table (18) showed that 1000 seed weight, percent oil and protein content were significantly affected due to dates of sowing in two years data. The 25 October (D_2) sowing date increased significantly maximum oil and Protein content in both years and mean value also over other dates of sowing. This may be due to long duration for growth and reproductive phase, favourable weather conditions and bold seed size, Narang and Singh (1987), Kurmi and Kalita (1991), Panda et al. (2004) were

also reported that early sowing increase seed size/oil and protein content than late sown crop.

EFFECT OF PLANTING GEOMETRIES:

The optimum plant population or planting space in the most important factor for a particular crop for increasing the yield in per unit area than other growth and yield deciding factors and agro techniques.

EFFECT ON GROWTH PHENOLOGY:

Reference to table (7 to 14) clearly showed that all round improvement in various growth characters were positively influenced with increasing planting geometries in both the years. The examination of the results in respect to growth parameters such as height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant and number of primary, secondary and tertiary branches/plant were significantly affected by different planting geometries. The above all growth characters were recorded maximum in planting geometry 60x15 cm(G_3) followed by 45x15 cm (G_2) and 30x15 cm (G_1) planting geometries, respectively in both the years.

The dry matter accumulation/plant is the positive response of plant growth and development. In this reference, table (12) revealed that planting geometry 60x15 cm (G_3) increased maximum dry matter/plant in different stages of growth in both the years and the final observation i.e. at harvest. On mean value base, it increased 1.76 and 4.75 percent more dry weight/plant over 45x15 cm(G_2) and 30x15 cm(G_1) planting

geometries, respectively. The maximum dry matter production/plant in wider planting geometry is due to more utilization of sun light, soil nutrient, soil moisture to individual plant and minimum competition effect between the plants, results more transformation of photosynthetes for development and growth. In this connection, the growth and development characters, duration of 50% flowering and 50% maturity were maximum in respective planting geometry 60x15 cm(G_3) followed by others. The same results were reported by Vir and Verma (1980), Singh and Singh (1987), Mishra and Rama (1992), Singh and Chauhan (2000), Mohan and Singh (2003) and Singh and Ram (2005).

EFFECT ON YIELD ATTRIBUTES AND YIELD:

A differential response of planting was observed in respect to yield attributes and yield. In table (15 and 16) it is clearly showed that all the yield contributing characters such as number of siliquae/plant, weight of siliquae/plant, length of siliqua, Number of seeds/siliqua, weight of seeds/siliqua and weight of seeds/plant were found maximum in planting geometry 60x15 cm (G_3) over other plant spaces. The per plant seed weight and their attributes were increased maximum in planting geometry 60x15 cm (G_3) due to more exposure of plant in sun light, more utilization of soil moisture and nutrients, more transformation of photosynthetes for reporudctive parts and minimum composition and shading effect among the plants. Vir and Verma (1980), Singh and Singh (1987), Chauhan et al.

(1993), Singh (1994), Singh and Chauhan (2000), Mohan and Singh (2003) were also reported similar results.

In respect to seed yield (q/ha) table (17) showed that significantly maximum seed yield (q/ha) was recorded in planting geometry 45x15 cm (G_2) in both the years. The pooled value was 3.82 and 5.86 percent more over 30x15 cm (G_1) and 60x15 cm (G_3) planting gemotries,respectively. The seed yield in q/ha is the resultant of number of plants/unit area, weight of seeds/plant and their yield contributing characters as number and weight of siliquae/plant, length and number of seeds/siliqua. Though the per plant seed weight and their yield attributes were recorded maximum in wider planting geometry 60x15cm (G_3) but number of plants/unit area was minimum, therefore, biomass production and seed yield in per unit area did not compensate to optimum planting geometry i.e. 45x15 cm (G_2) and reduced seed yield. The results were conformity with the findings of Vir and Verma (1980), Singh and Singh (1987), Singh (1994), Singh and Chauhan (2000) and Singh and Ram (2005). In closer planting geometry i.e.30x15 cm (G_1), the total number of plants/unit area was maximum but due to more plant population/unit area was not developed properly due to competition effect between plants and did not cover seed yield (q/ha) over the planting geometry 45x15 cm(G_2). Due to optimum plants/unit area and proper development of plants in 45x15 cm (G_2) planting space increased biomass production and seed yield in q/ha.

EFFECT OF GROWTH, YIELD ATTRIBUTES AND YIELD:

The maximum dry matter production/plant is the positive effect of growth characters such as height of main shoot, number of functional leaves/plant, Leaf area and number of branches/plant because, in wider planting geometry, the plant utilized more soil sources, more exposure of plant in sunlight to increase photosynthetic activity and accumulate food material in the plant. In this fact, the growth and development to the plant was increased which finally increased dry matter production in plant. The growth and development of plant pushed for increasing yield attributes and finally weight of seeds/plant. The above growth and yield characters were found maximum in 60x15 cm (G_3) planting geometry followed by other planting geometries. Though the growth and yield parameters were enhances and pushes to increase seed yield (q/ha) and biomass production. But due to minimum plants/unit area in 60x15cm (G_3) planting geometry could not compensate to cover seed yield and biomass production in q/ha as compare to optimum plant population. Therefore, seed yield and biomass production in q/ha was maximum in 45x15 cm (G_2) planting geometry. The similar results were also reported by Vir and Verma (1980), Singh and Singh (1987), Chauhan et al. (1993), Singh and Chauhan (2000), Mohan and Singh (2003) and Singh and Ram (2005).

EFFECT ON SEED QUALITY:

Among quality parameters, percent oil content and protein content in seed were significantly influenced by different

planting geometries in both the years data (Table 18). The above quality parameters data were recorded significantly maximum in wider planting geometry 60x15cm (G_3) followed by other plant spaces. It may be explained that in wider plant spaces take more nutrients and synthesized more aggimilates at a similar rate and proportion which produced bold seed size under wider planting geometry.

PERFORMANCE OF VARIETIES:

Varieties of any crop be have differently response from each other even when they are grown in similar atmosphere. The behaviour of those depends upon their genetic constitution. Their requirements of inputs for exploiting yield potential may vary when they are cultivated under same situation and atmosphere. The performance of mustard varieties tested in the present study is being discussed here.

EFFECT ON GROWTH PHENOLOGY:

It is evident from table (7 to 14) that different growth characters such as height of main shoot, number of functional leaves/plant, leaf area, fresh and dry weight/plant, number of primary, secondary and tertiary branches/plant, days to 50% flowering and 50% maturity were found maximum in variety Pusa bold (V_2) followed by the varieties Jagannath (V_3) and Varuna (V_1) respectively in both the years. The maximum dry matter production and more number of branches/plant in variety Pusa bold (V_2) indicate more development and growth of plant over other varieties. Gurjar and Chauhan (1997) Singh et al. (2001)

Veerya and Singh (2003) and Panda et al. (2004) also reported same results.

EFFECT ON YIELD ATTRIBUTES AND YIELD:

The seed yield is the past time response of number of plants/unit area weight of seeds/plant, number of branches/plant and yield contributing characters of the plant. The examination of the results given in table (17) showed that the seed yield (q/ha) was significantly maximum in variety Pusa bold (V_2) and pooled value was 12.50 and 21.69 percent additional in comparison to the varieties Jagannath (V_3) and Varuna (V_1) respectively. The same trend was also observed in weight of seeds/plant and their yield contributing characters such as number and weight of siliqua/plant, length of siliqua, number and weight of seeds/siliqua. Gurjar and Chauhan (1997), Singh (2001) Virya and Singh (2003) and Panda et al. (2004) were also reported the superiority of Pusa bold variety in seed yield over other tested varieties.

EFFECT ON GROWTH CHARACTERS, YIELD ATTRIBUTES AND YIELD:

The growth characters especially dry matter production per plant and number of different branches/plant indicate more development and spreading of plant. In other hand, more growth, development and number of branches/plant increased more number of siliquae/plant, weight of siliquae/plant and weight of seeds/plant. The examination of the table (7 to 14) that maximum growth and development and main

yield contributing characters such as dry weight/plant, number of primary, secondary and tertiary branches plant, number and weight of siliquae/plant and weight of seeds/plant were recorded in variety Pusa bold (V_2) over other varieties of mustard in existing agro climatic condition. The more growth development of plant and per plant main yield deciding characters were jointly increased maximum seed yield in q/ha. In this connection, the variety Pusa bold (V_2) produced significantly maximum seed yield and biomass production in q/ha in both the years and pooled value also over other tested varieties. The results were conformity with the findings of Gurjar and Chauhan (1997), Singh (2001), Virya and Singh (2003) and Panda et al. (2004).

EFFECT ON SEED QUALITY:

The presented table (18) clearly indicated that weight of 1000 seeds, percent oil and percent protein content in seed of mustard in both the years was recorded maximum in Pusa bold (V_2) variety and same trend was also observed in mean value of two years data. It is due to genetic characters to the variety.

INTERACTION EFFECT BETWEEN DATES OF SOWING AND PLANTING GEOMETRIES (DxG):

The interaction effect between DxG in growth characters such as height of main shoot at harvest, number of functional leaves/plant at 60 days, fresh weight/plant at 90days in both years and at harvest in 2004-05 years, dry weight/plant at 90 and at harvest in both years, number of secondary and tertiary branches/plant in 2004-05 year, days of 50% flowering

in both years, yield attributes such as number of siliquae/plant, weight of siliquae/plant in 2004-05, Length of siliqua in2003-04, Number of seeds/siliqua, weight of seeds/plant and percent oil content in both years were recorded significantly maximum in D_2G_3 interaction followed by other interactions of sowing dates and planting geometries in both years data. The separate improvement in sowing date D_2 (25 October) and planting geometry G_3 (60x15 cm) produced the maximum growth characters resulting higher yield attributes. It is due to optimum sowing time and more space between plants and more utilization of soil and atmospheric resources. Yadav and Singh (1992), Yadav et al. (1996) and Panda et al. (2004) also reported that 3rd and 4th weeks of October sowing time and Vir and Verma (1980), Singh and Singh (1987), Chauhan et al (1993), Singh and Chauhan (2000) and Mahan and Singh (2003) also reported that wider planting space increased maximum growth and yield characters in mustard.

The biomass production in both the years was significantly maximum in D_2G_2 interaction though the growth and yield attributes were maximum in D_2G_3 interactions. It might due to proper time for germination and long vegetative phase in respective sowing date and optimum plant population in per unit area basis. In jointly the D_2G_2 combination produced maximum total biomass production and seed yield in q/ha. Patel et al. (1980), Jadav and Singh (1992), Yadav et al. (1994), Yadav et al. (1996) and Panda et al. (2004) in sowing time and Vir and Verma

(1980), Singh and Chauhan (2000), Mahan and Singh (2003) Singh and Ram (2005) in planting spaces were also reported same results.

INTERACTION EFFECT BETWEEN DATES OF SOWING AND VARIETIES (DxV):

The interaction effect on height of main shoot, number of functional leaves/plant at 60 days, fresh weight/plant at 90 days, dry weight/plant at harvest in 2004-05, days of 50% flowering in both years, days of 50% maturity in 2004-05, number of siliquae per plant, weight of siliquae/plat in both years, weight of seeds per plant in 2004-05, total biomass production (q/ha) and harvest index in both years, were recorded significantly maximum in D_2V_2 interaction followed by other interactions of dates of sowing and varieties. It may be due to optimum time for a germination and long growth period for crop and genetical characters of variety. The Jadav and Singh (1992), Yadav et al. (1996) were reported more growth characters, yield attributes and Yield in 3rd and 4th weeks of October sowing date and Gurjar and Chauhan (1997), Singh et al. (2001), Panda et al. (2003) were reported the superiority of Pusa bold variety.

INTERACTION EFFECT BETWEEN PLANTING GEOMETRIES AND VARIETIES (GxV):

The interaction G_3V_2 was found superior due to separate superiority of G_3 (60x15 cm) planting geometry and V_2 (Pusa bold) variety in growth characters and yield attributes. The interaction effect to growth characters, such as height of main

shoot in 2004-2005 year, number of functional leaves/plant at 60 days in both years data, fresh weigt/plant and dry weight/plant at90 days in 2004-05, number of siliquae/plant in 2004-05 were recorded significantly maximum in G_3V_2 interaction over other interactions of planting geometries and varieties. It might be due to wider space between plants and more utilization of soil resources and minimum composition between plants and superiority to variety. The stover yield (q/ha) and harvest index in both years and percent protein content in 2004-05 were recorded significantly maximum in G_2V_2 interaction due to optimum plant population/unit area and proper development of plants. Vir and Verma (1980), Singh and Chauhan (2000), Mahan and Singh (2003) and Singh and Ram (2005) were also reported 45x15 cm plant spaces recorded maximum seed yield and biomass production in q/ha.

INTERACTION EFFECT BETWEEN DATES OF SOWING, PLANTING GEOMETRY AND VARIETIES (DxGxV):

The interaction effect between DxGxV in increasing growth characters such as height of main shoot at harvest in 2004-05, number of functional leaves/plant at 60 days in both years, leaf area at 60 days in 2004-05 year, Fresh weight/plant at 90 days in both years, dry weight/plant at 90 days in 2004-05, days of 50% flowering in 2003-04, number of secondary branches/plant and days of 50% maturity in 2004-05 year, weight of siliquae/plant in both years, weight ofseeds/plant in 2004-05 were recorded significantly maximum in $D_2G_3V_2$ interaction due to separate superiority of sowing date D_2 (25

October), G_3 (60x15 cm) and V_2 (Pusa bold) in growth parameters and yield attributes. The total produce (q/ha), stover yield (q/ha) and harvest index in both years were recorded significantly maximum in $D_2G_2V_2$ interaction due to separate improvement of respective sowing date planting geometry and variety. The same results were reported by Patel et al. (1980), Jadav and Singh (1992), Singh et al. (2001), Panda et al. (2004) in dates of sowing, Vir and Verma (1980), Singh and Singh (1987), Singh and Chauhan (2000), Mahan and Singh (2003) in planting spaces and Gurjar and Chauhan (1997),Singh et al. (2001), Virya and Singh (2003) and Panda et al. (2004).

EFFECT ON ECONOMICS:

In farming business, the economics have great importance to judge the best combination of input for getting maximum output. In this view, the economics was calculated and presented in table (19) and showed that maximum net returns (Rs/ha) mean value of two years are Rs. 14853.27, Rs. 14209.97 and Rs. 16358.29/ha was calculated in sowing date 25 October (D_2), planting geometry 45x15cm (G_2) and variety Pusa bold (V_2) respectively. The combined effect of $D_2G_2V_2$ was also accured maximum net profit Rs. 19436.07/ha over other dates of sowing, planting geometries and varieties. Form the net return base, the sowing date 25 October, planting geometry 45x15cm, and variety Pusa bold is the economic combination for mustard crop under the irrigated condition of Bundelkhand tract of U.P. It is mainly due to superior seed yield (q/ha) recorded under the respective combination.

Chapter - VII
SUMMARY AND CONCLUSION

CHAPTER – VII

SUMMARY AND CONCLUSION

The investigation entitled "Effect of sowing dates, Planting geometry and Varieties on growth, yield and quality of Mustard (Brassica juncea coss.) under irrigated condition" was carried out in Rabi season of 2003-04 and 2004-05 at Brahmanand Mahavidyalaya Research Farm, Rath (Hamirpur) U.P.

The variables involved in this study were three sowing dates (10 Oct., 25 Octo. And 10 Nov.), three planting geometries (30x15cm, 45x15 cm and 60x15 cm) and three mustard varieties (Varuna, Pusa bold and Jagannath). The 27 treatment combinations were compared under split plot design with three replications. The soil of the experimental field was 'Paruwa' (silty loam) according to the types of Bundelkhand soil having soil PH (7.8) organic carbon medium, Low in available nitrogen and phosphorus, high in available potassium. The electrical conductivity and cation exchange capacity were 0.34 (m mhos/cm) and 15.3 to 15.2 milli quivalent/100 gm soil, respectively.

The treatment effects on growth, yield attributes, yield and quality of the crop were determined in findings chapter. The important findings of the investigation are summarized in this chapter.

EFFECT OF SOWING DATES:

(1) The height of main shoot (cm) was significantly affected by dates of sowing in both years and was recorded maximum in D_2 (25 Oct.) sowing date followed by D_1 (10 Oct) and D_3 (10 Nov), respectively.

(2) The number of functional leaves/plant and leaf area were recorded significantly more in D_2 (25 Oct) sowing date over D_3 (10 Nov.) in both year while D_2 (25 Oct.), D_1 (10 Oct.) and D_1 (10 Oct.), D_3 (10 Nov.) were at par in both year.

(3) The fresh weight/plant (g) and dry weight/plant (g) were significantly differed among each other in both year under different sowing dates with maximum value in D_2 (25 Oct) followed by D_1 (10 Oct) and D_3 (10 Nov.) sowing dates, respectively.

(4) The number of primary, secondary and tertiary branches/plant in both years and mean value was recorded in D_2 (25 Oct.) followed by other sowing dates. The secondary and tertiary branches were significantly more in D_2 (25 Oct.) over D_3 (10 Nov.)

(5) The days to 50% flowering and 50% maturity was found more in D_1 (10 Oct.) sowing date in both the years and mean value over D_2 (25 Oct.) and D_3 (10 Nov.) sowing dates, respectively.

(6) The yield contributing characters such as number of siliquae/plant, weight of siliquae/plant (g), number of seeds/siliqua, weight of seeds/siliqua (mg) and weight of seeds/plant (g) were recorded significantly maximum in D_2 (25 Oct.) sowing date followed by D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively, in both the years.

(7) The total produce (q/ha) and stover yield (q/ha) were recorded significantly maximum in D_2 (25 Oct.) sowing date over D_1 (10Oct.) and D_3 (10 Nov.) respectively in both years.

(8) The seed yield (q/ha) was significantly maximum in sowing date D_2 (25 Oct.) in both years

The D_2 (25 Oct.) date of sowing increased 6.16 and 9.35 percent in 2003-04 and 8.89 and 10.32 percent in 2004-05 over the sowing dates such as D_1 (10 Oct.) and D_3 (10 Nov.), respectively. The pooled value of D_2 (25 Oct.) sowing date was also increased by 8.19 and 9.84 percent over D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively.

(9) The harvest index was non significantly affected by different sowing dates with more value in D_2 (25 Oct.) sowing date in both years.

(10) The weight of 1000 seeds (g) was recorded maximum in D_2 (25 Oct.) sowing date but the difference between sowing dates were non significant in both years.

(11) The percent oil content and protein content were significantly differed among each other in both years and mean value also. The significantly maximum values were recorded in D_2 (25 Oct.) followed by D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively.

(12) The maximum total net return (Rs/ha) was computed in D_2 (25 Oct.) sowing date in both years. The mean value in D_2 sowing date (Rs. 14853.27/ha) gained Rs. 1987.37 and Rs. 2376.99/ha as additional value as compared to D_1 (10 Oct.) and D_3 (10 Nov.) sowing dates, respectively.

EFFECT OF PLANTING GEOMETRIES:

(1) The initial and final plant population/unit area were recorded significantly higher in close planting geometry i.e. G_1 (30x15 cm) over G_2 (45x10 cm) and G_3 (60x15 cm) planting geometries, respectively, in both the years.

(2) The height of main shoot (cm) was recorded maximum in planting geometry G_3 (60x15 cm) which was significant over G_1 (30x15 cm)

(3) The number of functional leaves/plant was normally but leaf area (Cm^2) was significantly affected by different planting geometries in both the years. The above values were recorded maximum in G_3 (60x15 cm) followed by G_2 (45x15 cm) and G_1 (30x15 cm) planting geometries.

(4) The fresh weight/plant (g) and dry weight/plant (g) were recorded maximum in wider planting geometry i.e. G_3 (60x15cm) over other planting geometries in both the years. The G_3 (60x15 cm) was significantly superior over G_1 (30x15cm) in this regard.

(5) The number of primary, secondary and tertiary branches/plant were recorded significantly more in planting geometry G_3 (60x15cm), followed by the planting geometries such as G_2 (45x15 cm) and G_1 (30x15cm), respectively in both the years. The G_2 and G_1 were also significantly differed in these regard.

(6) The days of 50% flowering was noted more in G_1 (30x15cm) while the days of 50% maturity was increased in G_3 (60x15cm) over other planting geometries in both the years.

(7) The yield contributing characters such as number of siliquae/plant, length of siliquae (cm), number of seeds/siliqua, weight of siliqua (mg), and weight of seeds/plant (g) were recorded maximum in G_3 (60x15cm) followed by G_2 (45x15cm) and G_1 (30x15cm) planting geometries in both the years.

(8) The total produce (q/ha) and stover yield (q/ha) were significantly affected by planting geometries in both the years. The significantly maximum values were recorded in G_2 (45x15cm) over G_1 (30x15cm) and G_3 (60x15cm) planting geometries, respectively.

(9) The seed yield (q/ha) was significantly maximum in G_2 (45x15cm) planting geometry in both the years and increased 3.80 and 8.61 percent and 3.06 and 8.20 percent in 1st and 2nd years over G_1 (30x15cm) and G_3 (60x15cm) planting geometries, respectively.

(10) The harvest index was more in G_2 (45x15cm) and G_3 (60x15cm) planting geometries in 1st and 2nd years respectively. The above both geometries were significantly superior over G_1 (30x15cm) in this regard.

(11) The weight of 1000 seeds(g) was recorded maximum in G_3 (60x15cm) planting geometry followed by G_2 (45x15cm) and G_1 (30x15cm), respectively, in both the years.

(12) The percent oil content was significantly more in G_3 (60x15cm) in both the years over G_2 (45x15cm) and G_1 (30x15cm) planting geometries respectively.

(13) The percent protein content was also more in G_3 (60x15cm) planting geometries which was significant over G_1 (30x15cm) in both the years. The G_2 (45x15cm) was also more over G_1 in this regard.

(14) The maximum total net return (Rs/ha) was accured in G_2 (45x15cm) planting geometry in both the years. In mean value base, the respective planting space received Rs. 840.11/ha and Rs. 1594.41/ha more over G_1 (30x15cm) and G_3 (60x15cm) planting geometries, respectively.

PERFORMANCE OF VARIETIES:

(1) The height of main shoot (cm) was recorded significantly more in V_2 (Pusa bold) variety over other varieties such as V_3 (Jagannath) and V_1 (Varuna) except V_3 (Jagannath) at harvest in both the years.

(2) The number of functional leaves/plant and leaf area (cm) were recorded significantly more in variety V_2 (Pusa bold) followed by V_3 (Jagannath) and V_1 (Varuna) varieties in both the years and mean value also.

(3) The fresh and dry weight/plant (g) were recorded significantly maximum in V_2 (Pusa bold) variety over other varieties such as V_3 (Jagannath) and V_1 (Varuna) in both the years

(4) The number of primary, secondary and tertiary branches/plant were recorded maximum in V_2 (Pusa bold) variety followed by V_3 (Jagannath) and V_1 (Varuna) varieties in both the years.

(5) The days of 50% flowering was significantly more in variety V_2 (Pusa bold) while the days of 50% maturity was significantly higher in V_3 (Jagannath) followed by other varieties in different two year observations.

(6) The yield contributing characters such as number of siliquae/plant, weight of siliquae/plant (g), weight of seeds/siliquae (mg) and weight of seeds/plant (g) were significantly maximum in V_2 (Pusa bold) variety while

length of siliqua (cm) and number of seeds/siliqua were maximum over the varieties V_3 (Jagannath) and V_1 (Varuna), respectively, in both the years.

(7) The total produce (q/ha) and stover yield(q/ha) was significantly differed among the varieties in both the years and recorded maximum in V_2 (Pusa bold) over V_3 (Jagannath) and V_1 (Varuna) varieties, respectively.

(8) The seed yield (q/ha) was significantly maximum and increased 11.76 and 21.89 percent and 13.29 and 21.68 percent more in V_2 (Pusa bold) in both the years, respectively, over V_3 (Jagannath) and V_1 (Varuna) varieties,

(9) The harvest index was significantly differed among the varieties in both the years and recorded more in V_2 (Pusa bold) over V_3 (Jagannath) and V_1 (Varuna),

(10) The weight of 1000 seeds(g) was maximum in variety V_1 (Varuna) which was significantly more in 1st year over other varieties.

(11) The percent oil content was significantly maximum in V_2 (Pusa bold) varieties in both the years over V_3 (Jagannath) and V_1 (Varuna),

(12) The percent protein content was also maximum in V_2 (Pusa bold) varieties over other varieties in both the years.

(13) The maximum net return (Rs/ha) was received in V_2 (Pusa bold) variety in both the years with the mean value

base to Rs. 3308.51/ha and Rs. 5295.21/ha as additional over V_3 (Jagannath) and V_1 (Varuna)

CONCLUSION:

On the basis of result summarized in present investigation, the following conclusions are drawn:-

(1) The 25 Oct. sowing date was found most suitable for mustard crop.

(2) The planting geometry 45x15cm was found most suitable for mustard crop.

(3) The variety Pusa bold was found most suitable over Jagannath and Varuna varieties in this region.

(4) The combination of 25 Oct. sowing date, 45x15cm planting geometry and Pusa bold variety of mustard was found best and economic for mustard crop under the existing condition of Bundelkhand region of U.P.

Chapter - VIII
BIBLIOGRAPHY

CHAPTER - VIII

BIBLIOGRAPHY

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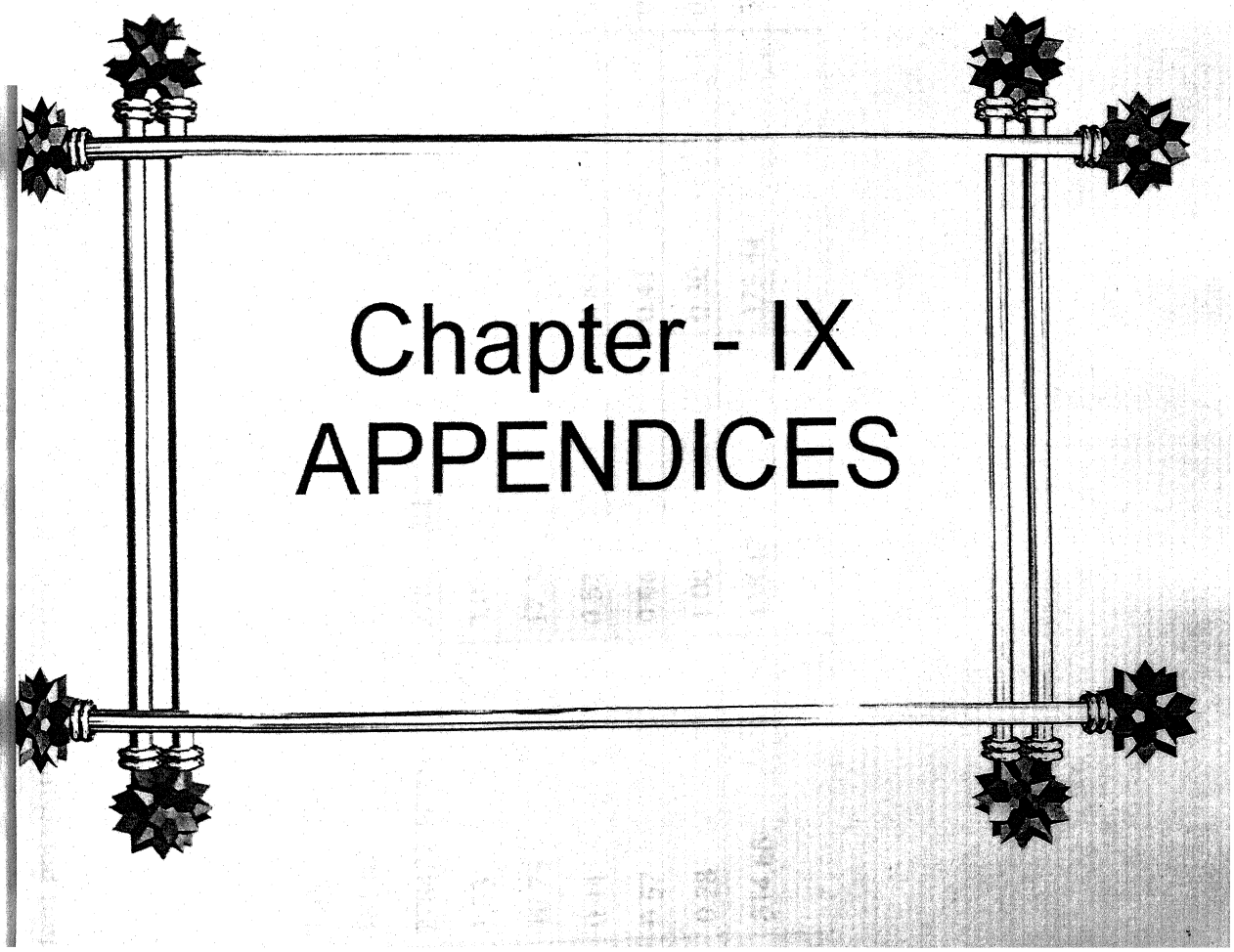

Chapter - IX
APPENDICES

APPENDIX - I : M.S.S. for initial and final plant population.

Sources of variation	D.F.	Initial plant population		Final plant population	
		2003-04	2004-05	2003-04	2004-05
Replication (R)	2	166.16	242.11	264.48	409.33
Sowing dates (D)	2	0.38	1.15	0.00	0.42
Error (E) - a	4	161.07	180.43	160.54	266.31
Planting geometry (G)	2	278427.12***	276780.04***	277113.48	278942.11***
D x G	4	1.53	3.07	2.26	0.93
Varieties (V)	2	10.75	17.37	23.04	22.26
D x V	4	0.44	0.52	0.81	0.41
G x V	4	0.57	0.96	0.41	0.15
D x G x V	8	0.28	1.00	0.30	0.30
Error (E) - b	48	314.68	438.47	373.44	306.06
Total	80				

APPENDIX - II : M.S.S. for Height of plant (Cm.) at different successive stages of growth..

Sources of variation	D.F.	30 days		60 days		90 days		At harvest	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	4.31	0.33	6.96	4.90	11.12	26.53	32.66	30.47
Sowing dates (D)	2	300.24***	259.05***	218.63***	22133.77***	510.77***	6426.29***	410.91***	5463.30***
Error (E) - a	4	6.35	0.28	2.97	2.20	8.91	32.90	13.26	8.87
Planting geometry (G)	2	24.24***	10.72**	217.15***	343.71***	342.12***	181.61	271.72***	106.87*
D x G	4	2.70	1.09	59.82*	34.54	24.03	100.57	2.48	69.90*
Varieties (V)	2	7.94*	8.30*	2070.30***	1971.17***	478.54***	187.36***	414.06***	295.50***
D x V	4	0.47	0.08	5.64	168.25***	4.76	13.60	19.41	569.82***
G x V	4	0.27	0.47	68.,32*	90.46**	22.12	3.03	10.35	153.01***
D x G x V	8	0.48	0.32	31.49	40.52*	12.94	27.00	5.30	129.29***
Error (E) - b	48	1.74	1.86	22.30	17.09	17.60	76.33	9.39	23.95
Total	80								

Appendix - III : M.S.S. for Number of Functional leaves/plant at different successive stages of growth.

Sources of variation	D.F.	Primary branches		Secondary branches		Tertiary branches	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	0.81	0.01	0.60	1.68	0.24	0.67
Sowing dates (D)	2	12.90***	27.06***	15.34***	127.84***	1.78	23.87***
Error (E) - a	4	1.18	0.01	0.32	0.74	0.65	0.56
Planting geometry (G)	2	2.03*	1.33*	43.45***	3.29*	11.02***	0.30
D x G	4	1.77*	0.06	8.29***	3.21**	0.64	0.14
Varieties (V)	2	6.32***	1.06***	102.58***	41.99***	7.77**	9.44***
D x V	4	1.40*	0.07	4.61*	4.16**	1.53	0.85
G x V	4	1.21	0.06	6.77**	4.50**	2.36	1.54
D x G x V	8	1.03	0.06	4.16**	2.35*	1.57	1.01
Error (E) - b	48	0.53	0.10	1.27	0.85	1.00	0.69
Total	80						

Appendix - IV : M.S.S. for Leaf area/plant (Cm^2) at different successive stages of growth.

Sources of variation	D.F.	Primary branches		Secondary branches		Tertiary branches	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	1509.35	143.61	8880.37	136969.77	342.51	61737.74
Sowing dates (D)	2	240093.90***	239311.84***	253968.38***	2477541.61***	67892.69***	322179.71***
Error (E) - a	4	492.66	33.88	5532.44	39872.03	2289.40	34758.51
Planting geometry (G)	2	191413.57***	190236.65***	327194.85***	2070170.86***	833754.54***	1358167.50***
D x G	4	2548.04***	2594.67***	605492.04***	37945.52*	291063.94***	15417.42
Varieties (V)	2	18351.45***	20540.44***	1096597.59***	1649758.05***	575417.11***	267686.82***
D x V	4	331.48	431.94*	10061.53***	76360.20***	14027.19***	57488.12*
G x V	4	369.00	597.20*	17198.84	197300.11***	86548.51***	36935.64
D x G x V	8	607.06	676.35***	57286.86	38640.62**	9516.15***	46985.41**
Error (E) - b	48	285.92	161.61	6710.66	13867.73	1046.96	15690.34
Total	80						

APPENDIX - (V) : M.S.S. for Fresh weight/plant (g) at different successive stages of growth.

Sources of variation	D.F.	30 days		60 days		90 days		At harvest	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	0.00	0.39	2.12	2.56	3.69	8.23	28.88	14.18
Sowing dates (D)	2	67.16***	62.23***	238.13***	168.25***	598.94***	4292.53***	180.70***	2612.06***
Error (E) - a	4	0.80	1.90	1.15	3.83	1.65	2.88	9.85	15.60
Planting geometry (G)	2	34.97***	48.18***	34.69***	192.13***	52.39**	55.17***	298.65***	252.21**
D x G	4	0.33	2.31	4.63	119.35***	139.31***	40.84***	79.89*	1.01
Varieties (V)	2	0.70	0.21	2.87	246.90***	1553.71***	1944.71***	3207.55***	23.27
D x V	4	1.20	0.08	3.65	25.48**	64.95***	598.36***	20.88	0.36
G x V	4	0.05	0.83	0.32	14.76*	18.36	32.27***	56.92	0.05
D x G x V	8	0.19	0.62	1.57	14.93**	62.47***	51.22***	42.41	0.32
Error (E) - b	48	1.48	1.50	2.27	4.83	8.79	4.17	25.59	32.12
Total	80								

APPENDIX - (VI) : M.S.S. for Dry weight/plant (g) at different successive stages of growth.

Sources of variation	D.F.	30 days		60 days		90 days		At harvest	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	0.12	0.00	4.52	2.31	4.00	27.60	1.16	0.43
Sowing dates (D)	2	16.75***	14.88***	49.29***	1067.81***	91.13***	1089.81***	31.49***	235.76***
Error (E) - a	4	0.11	0.09	2.53	1.08	1.50	5.65	1.35	1.26
Planting geometry (G)	2	3.05***	4.19***	8.09**	73.14***	20.60***	82.20***	26.75***	10.43*
D x G	4	0.87***	0.36**	2.34	19.74***	2.41	43.35***	14.10***	1.96
Varieties (V)	2	0.48***	1.18***	3.40	410.04***	7.94**	540.68***	152.80***	2.52
D x V	4	0.05	0.02	0.37	6.51**	0.76	36.08***	21.49***	0.38
G x V	4	0.12*	0.02	0.15	19.87***	0.24	21.53***	0.56	0.05
D x G x V	8	0.06	0.07	0.52	24.21***	0.25	27.03***	3.22	0.11
Error (E) - b	48	0.04	0.09	1.28	1.21	1.00	3.75	1.89	2.75
Total	80								

Appendix - (VII) : M.S.S. for Number of Primary, Secondary and Tertiary branches/plant.

Sources of variation	D.F.	Primary branches		Secondary branches		Tertiary branches	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	0.07	0.40	8.12	0.29	1.04	0.04
Sowing dates (D)	2	0.73*	0.60	43.79***	40.20***	4.94***	9.00***
Error (E) - a	4	0.21	0.37	3.42	0.36	0.34	0.28
Planting geometry (G)	2	26.11***	23.62***	101.21***	109.67***	89.15***	100.14***
D x G	4	0.61	0.89	2.16	2.06**	2.25	1.82***
Varieties (V)	2	3.69***	4.66**	8.03*	8.26***	9.28***	11.72***
D x V	4	0.40	0.59	0.41	0.52	0.22	0.38
G x V	4	0.08	0.26	0.18	0.70	0.40	0.50
D x G x V	8	0.13	0.05	0.69	2.12***	0.33	0.55
Error (E) - b	48	0.32	0.52	2.50	0.51	0.91	0.26
Total	80						

APPENDIX - VIII : M.S.S. for Days of 50% flowering & Days of 50% maturity

Sources of variation	D.F.	Days of 50% flowering		Days of 50% maturity	
		2003-04	2004-05	2003-04	2004-05
Replication (R)	2	3.42	5.98	12.98	3.72
Sowing dates (D)	2	1246.31***	1489.64***	55.05**	177.23***
Error (E) - a	4	5.36	1.94	7.60	3.53
Planting geometry (G)	2	22.98***	12.96*	0.53	37.934***
D x G	4	31.92***	45.77***	16.38	24.59***
Varieties (V)	2	200.09***	207.75***	31.28	22.31**
D x V	4	1.03	15.83***	25.77	37.62***
G x V	4	1.03	8.49*	3.48	48.10***
D x G x V	8	6.03*	2.90	14.05	11.03*
Error (E) - b	48	2.42	2.77	13.01	4.05
Total	80				

Appendix - IX : M.S.S. for Yield contributing characters.

Sources of variation	D.F.	Number of siliquae/plant		Weight of siliquae/plant (g)		Length of siliqua (cm)		Number of seeds/ siliqua		Weight of seeds/ siliqua (mg)		Weight of seeds/ plant (g)	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	253.35	2121.59	6.90	26.26	0.08	0.04	0.19	0.42	1.88	7.57	2.37	1.36
Sowing dates (D)	2	56732.64***	8181.44***	978.38***	129.33**	0.11	0.17	50.32***	7.20***	286.17***	992.07***	27.17***	31.15***
Error (E) - a	4	1265.31	606.81	10.94	17.93	0.10	0.50	0.47	0.55	7.14	8.44	1.40	0.44
Planting geometry (G)	2	1259.12	4283.26*	39.86*	140.48***	0.23	0.29	1.93	3.69*	19.66*	3.88	5.29	0.06
D x G	4	1589.20	4401.87**	16.79	161.93***	0.99**	0.56	2.57*	4.65**	85.05***	15.70***	16.56***	4.82
Varieties (V)	2	67178.68***	2559.37	860.79***	24.33	0.63	0.01	3.02*	5.96**	878.39***	48.95***	210.42***	9.24*
D x V	4	99636.09***	30.79.09*	603.88***	28.78*	0.52	0.17	0.49	4.87**	76.99***	51.55***	27.76***	2.11
G x V	4	311.07	4570.85**	9.03	102.61***	0.47	0.24	2.92*	1.18	114.98***	51.30***	4.25	3.77
D x G x V	8	1304.56	879.41	25.85*	22.51	0.24	0.58*	2.15*	4.15***	39.91***	24.20***	3.93	13.25**
Error (E) - b	48	1507.88	1150.64	9.77	7.98	0.24	0.24	0.92	0.92	5.89	2.24	2.56	2.56
Total	80												

APPENDIX - (X) : M.S.S. for Total produce(q/ha), Seed yield(q/ha), Stover yield (q/ha) and Harvest Index.

Sources of variation	D.F.	Total produce (q/ha)		Seed yield (q/ha)		Stover yield (q/ha)		Harvest Index	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	5.94	3.80	0.05	1.33	24.18	4.57	0.18	4.55
Sowing dates (D)	2	312.73***	376.58***	14.11***	18.01***	173.76***	273.37***	14.94	2.90
Error (E) - a	4	2.89	2.31	0.11	2.75	8.23	2.49	5.55	1.72
Planting geometry (G)	2	180.41***	203.89***	4.56*	8.58*	168.57***	318.61***	68.45***	68.28***
D x G	4	34.52***	33.39***	1.51	3.99	20.49*	73.13***	23.95***	21.61***
Varieties (V)	2	1796.66***	1753.33***	77.24***	77.70***	1586.39***	1494.91***	192.01***	388.84***
D x V	4	36.87***	13.79*	0.90	2.12	15.08	22.30**	44.26***	6.40***
G x V	4	20.55*	53.46***	0.79	2.00	54.44***	41.25***	61.42***	9.36***
D x G x V	8	44.75***	15.5.2**	1.31	2.32	54.09***	48.08***	21.68***	24.26***
Error (E) - b	48	5.61	5.30	1.52	2.20	6.72	5.16	2.40	0.81
Total	80								

Appendix - XI : M.S.S. for Weight of 1000 seeds (g), Oil content (in %) and Protein content (in %).

Sources of variation	D.F.	1000 seeds weight (g)		Oil content (%)		Protein content (%)	
		2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Replication (R)	2	0.11	0.07	3.21	0.08	0.21	0.17
Sowing dates (D)	2	0.03	0.26	385.49***	449.07***	66.25***	82.72***
Error (E) - a	4	0.06	0.78	1.24	0.20	0.15	0.35
Planting geometry (G)	2	0.86**	0.02	10.18***	34.89***	8.02***	2.04
D x G	4	0.02	0.06	6.17**	0.86	0.46	2.13*
Varieties (V)	2	4.94***	0.05	77.02***	8.05***	1.70***	1.21
D x V	4	0.12	0.08	31.99***	1.09	0.04	3.19**
G x V	4	0.19	0.03	1.54	0.70	0.17	4.04***
D x G x V	8	0.03	0.02	2.24	0.97	0.17	3.82***
Error (E) - b	48	0.12	0.20	1.25	0.63	0.19	0.64
Total	80						

Appendix- XII(a): Common cost of cultivation of mustard crop.

S.N	Operations	Cost (Rs/ha)	
		2003-04	2004-05
1.	LAND PREPARATION		
(i)	One ploughing with soil turning plough (3 pairs bullock and 3 labour male one day)	330.00	330.00
(ii)	Two ploughing with Deshi plough (4pairs of bullock and 4 labour male one day)	440.00	440.00
2.	SEED AND SOWING		
(i)	Cost of seed (7.0Kg seed/ha @Rs.20.00/Kg)	140.00	140.00
(ii)	Cost of sowing (4 pairs of bullock and 4 labour male one day)	340.00	340.00
3.	RIDGE MAKING (4 labour one day) @Rs60=00/day	240.00	240.00
4.	THINNING AND WEEDING (20 labour female for one day)@Rs 50=00 1day	1000.00	1000.00
5.	FERTILIZER APPLICATION		
(i)	Cost of Nitrogen (80Kg N_2/ha @Rs.4.83/Kg of Urea)	838.48	838.48
(ii)	Cost of Phosphorus (40Kg of P_2O_5/ha @Rs.3.00/Kg of S.S.P.)	750.00	750.00
(iii)	Cost of Potassium (30 Kg K_2O/ha @Rs.4.45/Kg of M.O.P.)	222.50	222.50
(iv)	Cost of application (2 labour for one day)	120.00	120.00

6.	IRRIGATION		
(i)	Two irrigation (time 15 hours/ha @Rs.25/hr.)	750.00	750.00
(ii)	Labour charge (2 labours male for each irrigation)	240.00	240.00
7.	PLANT PROTECTION (2 sprayings of insecticides and pesticides as precaution and protection.		
(i)	Cost of Insecticide through Indosulphan @Rs.300/litre	300.00	300.00
(ii)	Cost of sprayings (2 labours male for each sprayings)	240.00	240.00
8.	REPAIR TO DEAD STOCK(@Rs.0.50/unit)	9.00	9.00
9.	LAND VALUE DURING CROP PERIOD	1500.00	1500.00
10.	INT.. TO WORKING CAPITAL (@ 7% during crop period)	592.19	592.19
	Total common cost of cultivation(Rs/ha)	9052.17	9052.17

Appendix- XII(b): Cost of harvesting, loading, threshing and winnowing etc. for the basis of 30x15, 45x15 and 60x15 cm planting geometry.

S.N	Operations	Cost (Rs/ha)
1.	Cost of harvesting (15 women labours for one day)	750.00
2.	Bundle making and loading (5 labours (male) and card load with bullock for one day)	380.00
3.	Threshing (3 pairs of bullock and 4 labour one day)	390.00
4.	Winnowing (6 labours, 3 Men and 3 Women for one day)	330.00
5.	Repair to Dead stock @Rs. 0.50/pair of bullock	2.00
	Total	1852.00
6.	Interest to working capital @ 7% during crop period	129.64
7.	Miscellaneous	100.00
	Total	2081.64

1. Per quintal cost in 2003-04 (17.39 q/ha) =
2. Per quintal cost in 2004-05 (17.25 q/ha) =

Appendix - XII (c) : Statement of Total cost of cultivation (Rs./ha),Total gross income (Rs/ha),Total Net income (Rs/ha) and B/C ratio.

S.N.	Treatments	Cost of harvesting (Rs/ha)			Total cost of cultivation (Rs/ha)			Seed yield (q/ha)	
		2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05
1.	$D_1G_1V_1$	1413.69	1400.97	1407.33	10465.86	10453.14	10459.50	11.81	11.61
2.	$D_1G_1V_2$	1709.31	1714.78	1712.04	10761.48	10766.95	10764.22	14.28	14.21
3.	$D_1G_1V_3$	1469.91	1515.61	1492.76	10519.08	10567.78	10453.43	12.28	12.56
4.	$D_1G_2V_1$	1485.47	1419.07	1452.27	10537.64	10471.24	10504.44	12.41	11.76
5.	$D_1G_2V_2$	1823.03	1921.06	1872.05	10875.20	10973.23	10924.22	15.23	15.92
6.	$D_1G_2V_3$	1596.80	1516.82	1556.81	10648.97	10568.99	10608.98	13.34	12.57
7.	$D_1G_3V_1$	1343.03	1467.34	1405.19	10395.20	10519.51	10457.36	11.22	12.16
8.	$D_1G_3V_2$	1748.82	1822.11	1785.47	10800.99	10874.28	10837.64	14.61	15.10
9.	$D_1G_3V_3$	1511.81	1700.24	1606.03	10563.98	10752.41	10658.20	12.63	14.09
10.	$D_2G_1V_1$	1515.40	1419.07	1467.24	10567.57	10471.24	10519.41	12.66	11.76
11.	$D_2G_1V_2$	1941.53	1884.86	1913.20	10993.70	10937.03	10965.37	16.62	15.62
12.	$D_2G_1V_3$	1706.92	1642.31	1674.62	10759.09	10694.48	10726.79	14.26	13.61
13.	$D_2G_2V_1$	1559.69	1750.92	1655.31	10611.86	10803.09	10707.48	13.03	14.51
14.	$D_2G_2V_2$	2081.58	2081.55	2081.57	11133.75	11133.72	11133.74	17.39	17.25
15.	$D_2G_2V_3$	1806.27	1969.33	1887.80	10858.44	11021.50	10939.97	15.09	16.32
16.	$D_2G_3V_1$	1447.17	1352.71	1399.94	10499.34	10404.88	10452.11	12.09	11.21
17.	$D_2G_3V_2$	1863.72	2056.21	1959.97	10915.89	11108.38	11012.14	15.57	17.04
18.	$D_2G_3V_3$	1587.22	1724.37	1655.80	10639.39	10776.54	10707.97	13.26	14.29
19.	$D_3G_1V_1$	1355.00	1408.21	1381.61	10407.17	10460.38	10433.78	11.32	11.67
20.	$D_3G_1V_2$	1886.47	1848.66	1867.57	10938.64	10900.83	10919.74	15.76	15.32
21.	$D_3G_1V_3$	1577.64	1411.83	1494.74	10629.81	10464.00	10546.91	13.18	11.70
22.	$D_3G_2V_1$	1533.35	1562.67	1548.01	10585.52	10614.84	10600.18	12.81	12.95
23.	$D_3G_2V_2$	1667.42	1632.66	1650.04	10719.59	10684.83	10702.21	13.93	13.53
24.	$D_3G_2V_3$	1580.04	1608.53	1594.29	10632.21	10660.70	10646.46	13.20	13.33
25.	$D_3G_3V_1$	1297.54	1359.95	1328.75	10349.71	10412.12	10380.92	10.84	11.27
26.	$D_3G_3V_2$	1808.66	1877.62	1843.14	10860.83	10929.79	10895.31	15.11	15.56
27.	$D_3G_3V_3$	1643.48	1459.92	1571.70	10695.65	10551.69	10623.67	13.73	12.43

Appendix- XII (c) : Contd.....

S.N.	Treatments	Total gross income (Rs/ha)			Net income (Rs/ha)			B/C ratio		
		2003-04	2004-05	Mean	2003-04	2004-05	Mean	2003-04	2004-05	Mean
1.	$D_1G_1V_1$	20844.65	20491.65	20668.15	10378.79	10038.51	10208.65	0.99	0.96	0.97
2.	$D_1G_1V_2$	25204.20	25080.65	25142.43	14442.72	14313.70	14378.21	1.34	1.32	1.33
3.	$D_1G_1V_3$	21674.20	22168.40	21921.30	11115.12	11600.62	11377.87	1.06	1.09	1.07
4.	$D_1G_2V_1$	21903.65	20756.40	21330.03	11366.01	10285.16	10825.59	1.07	0.98	1.02
5.	$D_1G_2V_2$	26880.95	28098.80	27489.88	16005.75	17125.57	16565.66	1.47	1.56	1.51
6.	$D_1G_2V_3$	23545.10	22186.05	22865.58	12869.13	11617.06	12256.59	1.21	1.09	1.15
7.	$D_1G_3V_1$	19803.30	21462.40	20632.85	9408.10	10942.89	10175.50	0.90	1.04	0.97
8.	$D_1G_3V_2$	25786.65	26651.50	26219.08	14985.66	15777.22	15381.44	1.38	1.45	1.41
9.	$D_1G_3V_3$	22291.95	24868.85	23580.40	11727.97	14116.44	12922.21	1.11	1.31	1.21
10.	$D_2G_1V_1$	22344.90	20756.40	21550.65	11777.33	10285.16	11031.25	1.11	1.98	1.04
11.	$D_2G_1V_2$	29334.30	27569.30	28451.80	18340.60	16632.27	17486.44	1.66	1.52	1.59
12.	$D_2G_1V_3$	25168.90	24021.65	24595.28	14409.81	13327.17	13868.49	1.33	1.24	1.28
13.	$D_2G_2V_1$	22997.95	25610.15	24304.05	12386.09	14807.06	13596.58	1.16	1.37	1.26
14.	$D_2G_2V_2$	30693.35	30446.25	30569.80	19559.60	19312.53	19436.07	1.75	1.73	1.74
15.	$D_2G_2V_3$	26633.85	28804.80	27719.33	15775.41	17783.30	16779.36	1.45	1.61	1.53
16.	$D_2G_3V_1$	21338.85	19785.65	20562.25	10839.51	9380.77	10110.14	1.03	0.90	0.96
17.	$D_2G_3V_2$	27481.05	30075.60	28778.33	16565.16	18967.22	17766.19	1.51	1.70	1.60
18.	$D_2G_3V_3$	23403.90	25221.85	24312.88	12764.51	14445.31	13604.91	1.19	1.34	1.26
19.	$D_3G_1V_1$	19979.80	20597.55	20288.68	9572.63	10137.17	9854.90	0.91	0.96	0.93
20.	$D_3G_1V_2$	27816.40	27039.80	27428.10	16877.76	16138.97	16508.37	1.54	1.48	1.51
21.	$D_3G_1V_3$	23262.70	20650.50	21956.60	12632.89	10186.50	11409.70	1.18	0.97	1.07
22.	$D_3G_2V_1$	22609.65	22856.75	22733.20	12024.65	12241.91	12133.28	1.13	1.15	1.14
23.	$D_3G_2V_2$	24586.45	23880.45	24233.45	13866.86	13195.62	13531.24	1.29	1.23	1.26
24.	$D_3G_2V_3$	23298.00	23527.45	23412.73	12665.79	12866.75	12766.27	1.19	1.20	1.19
25.	$D_3G_3V_1$	19132.60	19891.55	19512.08	8782.89	9479.43	9131.16	0.84	0.91	0.87
26.	$D_3G_3V_2$	26669.15	27463.40	27066.28	15808.32	16533.61	16170.97	1.45	1.51	1.48
27.	$D_3G_3V_3$	24233.45	21938.95	23086.20	13537.80	11387.26	12462.53	1.26	1.07	1.16

Total Common cost of cultivation: Rs. 9052.17/ha. Cost of harvesting: Rs. 2081.64/ha.

Per quintal cost (2003-04) on basis of 17.39 q/ha. = Rs. 119.70/quintal of seed yield

Per quintal cost (2004-05) on basis of 17.25 q/ha. = Rs. 120.67/quintal of seed yield

Market price of Mustard above both year = Rs. 1765/quintal.